MV-22 SQUADRON ORGANIZATION: A DIFFERENT WAY TO SUPPORT

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The United States Marine Corps has seen a steady increase in demand for its MV-22 capabilities since its first deployment in 2007. The MV-22 community is at a tipping point of its ability to support its operational requirements. This thesis seeks to describe the current state of the MV-22 community by studying the MV-22 model manager MAG-26. Examining the maintenannce data since 2013 shows a decrease in the ability to maintian aircraft. This is due to several factors, a loss of maintnenance proficiency, a loss of aircrew and pilot proficiency, decreased retention rates, a decrease in dwell-to-deploy time, increase in transfer of aircrafts, and incompatable parts with multiple MV-22 configurations. This thesis will explore solutions to these issues and make recommendations on how a change in squadron organization can regain pilot, aircrew, and maintenance proficiency along with increasing aircraft mission capable rate.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

MV-22 SQUADRON ORGANIZATION: A DIFFERENT WAY TO SUPPORT, by Maj Bret J. Knickerbocker, 97 pages.

The United States Marine Corps has seen a steady increase in demand for its MV-22 capabilities since its first deployment in 2007. The MV-22 community is at a tipping point in its ability to support its operational requirements. This thesis seeks to describe the current state of the MV-22 community by studying the MV-22 model manager MAG-26. Examining the maintenance data since 2013 shows a decrease in the ability to maintain aircraft. This is due to several factors; a loss of maintenance proficiency, a loss of aircrew and pilot proficiency, decreased retention rates, a decrease in dwell-to-deploy time, increase in transfer of aircrafts, and incompatible parts with multiple MV-22 configurations. This thesis will explore solutions to these issues and make recommendations on how a change in squadron organization can regain pilot, aircrew, and maintenance proficiency along with increasing aircraft mission capable rate.

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Thanks to my wife and family for all the support and to my committee for guidance and holding my feet to the fire.

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ACRONYMS

ACE	Aviation Combat Element
AMHS	Automated Message Handling System
AMSRR	Aviation Management Supply and Readiness Reporting
ATO	Aircraft Transfer Orders
CANN	Cannibalization
CONUS	Continental United States
F/AD	Force Activity Designator
FMC	Full Mission Capable
FRS	Fleet Replacement Squadron
FY	Fiscal Year
MAG	Marine Air Group
MAGTF	Marine Air Ground Task Force
MALS	Marine Aviation Logistics Squadron
MAW	Marine Aviation Wing
MC	Mission Capable
MCAS	Marine Corps Air Station
MEU	Marine Expeditionary Unit
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OOMA	Optimized-Organizational Maintenance Activity
OOR	Out of Reporting
PMC	Partial Mission Capable
PSD	Personnel Detachment

RBA	Ready Based Aircraft
SPMAGTF-CR	Special Purpose Marine Air Ground Task Force-Crisis Response
SPMAGTF-CR-AF	Special Purpose Marine Air Ground Task Force-Crisis Response-U.S. Africa Command
SPMAGTF-CR-CC	Special Purpose Marine Air Ground Task Force-Crisis Response-U.S. Central Command
T/E	Table of Equipment
T/O	Table of Organization
TYCOM	Type Commander
USMC	United States Marine Corps
VMM	Fixed Wing Marine Medium Squadron (Tiltrotor Squadron)

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CHAPTER 1

INTRODUCTION

Introduction/Background

The purpose of this study is to analyze the current organizational make up of a MV-22 squadron in order to determine if a change in size and composition would result in an increased ability to fly aircraft, train personnel, and increase deploy-to-dwell time. The focus of this thesis will be on three topics: maintenance data, dwell-to-deploy data, and MV-22 squadron design.

The MV-22 community faces increasing operational demand, sustained high deployment rates, downsizing of trained/qualified personnel, and continued creation of Fixed-Wing Marine Medium (VMM) squadrons. The MV-22 utilizes a technology that has never been used by the military. Increased speed, range, and the ability to take-off and land like a helicopter, laid the foundation for a platform that has insatiable operational demand. MV-22 squadrons have struggled to keep up with operational demand due to a combination of high aircraft transfer rates, low mission capable (MC) rates of the airframes, and reduced time to train aircrews between deployments. 2006 marked the creation of the first operational VMM squadron[1] and over the last ten years, the community has grown exponentially.

[1] Marine Corps Center for Lessons Learned (MCCLL), Training and Education Command, *MV-22 Tiltrotor Operations in Iraq-Lessons and Observations from VMM-263 Deployed October 2007 - April 2008 OIF 06-08.2* (Quantico, VA: Training and Education Command, 14 May 2008), accessed 14 November 2016, https://www.mccll.usmc.mil/index.cfm?disp=myIdolSearch_xml.cfm&refine=Campaign|OIF, 1.

The MV-22 community is the largest aviation community in the United States Marine Corps (USMC). There are six operational squadrons, and one training squadron at Marine Corps Air Station (MCAS) New River, Jacksonville, NC; two operational squadrons in Okinawa, Japan; seven operational squadrons, and one reserve squadron, at MCAS Miramar, San Diego, CA; one operational test squadron at MCAS Yuma, AZ; one reserve squadron at Norfolk, VA; the developmental test squadron at Patuxent River, MD; and the presidential support MV-22s at Quantico, VA.[2] Additionally, within two years, two more squadrons will be created in Hawaii. The USMC fleet is in full support of an east coast Marine Expeditionary Unit (MEU), west coast MEU, Okinawan MEU, along with support of a Special Purpose Marine Air Ground Task Force-Crisis Response-African Command (SPMAGTF-CR-AF) and SPMAGTF-CR-Central Command (SPMAGTF-CR-CC). Stresses on MV-22 squadrons and the supply system have never been higher, especially with the high aircraft transfer rate being utilized to support the current tempo.

Transferring of unit aircraft is normal; however, continuously transferring aircraft becomes a problem. Habitual transfers result in no ownership of aircraft within a squadron and the overall condition of aircraft begins to degrade. Rotary wing procedures for Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) were to leave aircraft in place and have squadrons rotate in on those aircraft. This meant the unit would transfer all their aircraft when they left home station and then accept a squadron of aircraft when returning from deployment. Since the MV-22 community was made up of

[2] Marine Aircraft Group 26, "The Mission of VMM," U.S. Marine Corps," accessed 14 November 2016, http://www.mag26.marines.mil/MAG-26-Units/VMM-263.

primarily rotary wing aviators, they did the same thing. This process continues today and has made Marine Air Group-26 aircraft a constantly rotating stock, utilized for a year or two and then turned over to another unit within the MAG.

In addition to transfers in support of deployments, transfers are conducted based on specific aircraft capabilities. Since becoming operational ten years ago,[3] the MV-22 has undergone several factory upgrades along with aftermarket modifications, often referred to as mods, completed by contracted Fleet Support Representatives. The numerous configurations of the MV-22 created a situation where specific aircraft are preferred or required over others to conduct certain types of deployments. This significantly added to the number of transfers and singled out certain aircraft configurations that lack mods being terminally transferred from squadron to squadron, often becoming aircraft that are severely neglected.

Numerous configurations create a challenge for the decision of which aircraft go on what deployment and a challenge the individual squadron maintainer and the supply/repair parts system. With so many different configurations, different manufacturer vendors, different production rates, one-time use parts, repairable parts, and consumable parts; it is a very challenging environment. At times, the supply system cannot keep up with demand and the squadron is forced to cannibalize[4] (CANN) a part from another

[3] MCCLL, *MV-22 Tiltrotor Operations in Iraq-Lessons and Observations from VMM-263.*

[4] Cannibalization (CANN) is an accepted naval aviation practice. It is governed under Commander, Naval Air Forces, COMNAVAIRFORINST 4790.2C, *Naval Aviation Maintenance Program*. It is the practice of removing parts from one aircraft and installing them on another aircraft. This practice is tracked in the maintenance recording system Optimized-Organizational Maintenance Activity (OOMA) and the data can be

aircraft. Due to the size of the MV-22 community and number of parts required to keep it operating, the process of prioritization of parts is regimented. The presidential MV-22s get first priority, and then it is split amongst deployed squadrons and squadrons in Japan; whatever is left goes to the non-deployed squadrons in the continental United States (CONUS).[5] CONUS squadrons regularly struggle to get parts needed and resort to CANNing. There simply are not enough parts available to keep the community flying. Only through the experience, qualifications, and talent of the individual maintainer, have the MV-22 squadrons been able to meet mission obligations.

The technology of the MV-22 requires several years of experience for an individual to develop advanced maintenance qualifications. The current operational tempo and nature of deployments is not supportive to creating qualified maintainers, or retaining those trained and qualified maintainers in the Marine Corps.

With difficulty maintaining retention of critical personnel, squadrons are beginning to face shortfalls of maintenance required, versus maintenance supportable. Due to the Table of Organization (T/O), Table of Equipment (T/E), and acquisitions process, contractors have become an integral part in the support of daily MV-22

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pulled from DECKPLATE. CANNing does increase workload and decreases morale because of the additional workload.

[5] Squadrons are assigned a Force/Activity Designator (F/AD) that designates it priority for parts. The presidential support squadron is the only squadron in the USMC that is F/AD-1. They will receive parts before any other squadron. If necessary, parts will be CANNed from other aviation squadrons to supply an F/AD-1 squadron. Deployed squadrons and squadrons within thirty days of deployment are F/AD-2. For the MV-22 community, squadrons in Okinawa are also F/AD-2. CONUS based squadrons not within thirty days of deployment are F/AD-3. They are the lowest priority for parts and often have long waits for limited supply items. If an F/AD-3 has had a part on order for three months a squadron with a higher F/AD status will get the part first even if they requested it one day prior.

operations. Through the acquisitions process, several maintenance actions are still being performed by industry representatives due to lack of purchasing the rights or blueprints for servicing and repairing specific aircraft components. In CONUS, with the shortage of qualified personnel, there is more work to be done than maintainers can perform. MCAS New River has several teams of contract maintainers that are sent to individual squadrons on a daily basis.[6] As the need for contractors has increased, more jobs have become available to qualified maintainers. This actually increases the need for even more contractors, as qualified maintainers leave the military to become contractors.

Problem Statement

The USMC MV-22 community is experiencing increased deployment cycles, increased attrition of pilots and mechanics, and increased maintenance requirements. The current squadron T/O, T/E lacks sufficient depth to sustain the current operational tempo, maintain aircraft, and has had a negative effect on retention of squadron personnel.

Research Question

The primary research question is: will a change in T/O, T/E, and aircraft assigned increase MAG-26, MV-22 squadron's ability to fly, train, and retain maintainers, aircrew, and increase dwell-to-deploy time? The follow-on questions that must be answered to address the primary question are: (1) why does a MV-22 squadron have twelve aircraft assigned; (2) have the mission requirements changed from what was originally estimated or planned, and are the current T/O and T/E designed to support the change; (3) has there

[6] There are twenty-five permanent contract maintainers at VMMT-204 and forty roving contract maintainers that are controlled by Marine Aviation Logistics Squadron 26 that are sent by priority to the Marine Corps Air Station New River squadrons.

been a decrease in aircraft MC rates associated with the decrease in dwell-to-deploy time; (4) has there been an increase in unit aircraft transfers with decreased dwell-to-deploy time; and (5) has there been a decrease in the trained personnel retention rate with the decreased dwell-to-deploy time?

Quantitative analysis will be used to determine the answers to the questions posed. Historical aircraft maintenance data will be pulled from DECKPLATE.[7] Retention rates will be pulled from Manpower and Reserve Affairs and compared to other USMC aviation communities. The mission and design of a MV-22 squadron will be pulled from Headquarters Marine Corps Aviation.

Assumptions

The USMC will retain its current manning numbers and not increase the force. Any increase in the MV-22 T/O will cause a decrease in T/O for another unit. The demand for MV-22 capabilities will remain the same or increase for the foreseeable future. Although SPMAGTF's are by nature temporary, SPMAGTF-CR-AF and SPMAGTF-CR-CC will remain an enduring mission for several years.

Definition of Terms

Dwell-to-Deploy Ratio: The ratio of time home versus time deployed. The higher the dwell-to-deployed ratio, the more time available to train and prepare for deployments.

Fixed Wing Marine Medium Tiltrotor Squadron: Commanded by a lieutenant colonel, a VMM is the basic building block of all Marine aviation. When a MEU forms an Aviation Combat Element (ACE), the VMM is the core squadron that has detachments

[7] DECKPLATE is the Navy web-based repository for all maintenance data.

from CH-53, AH-1, UH-1, and AV-8 squadrons assigned to it. The VMM commanding officer becomes the MEU ACE commanding officer. The mission of a VMM is to "Provide assault support of combat troops, supplies and equipment during amphibious operations and subsequent operations ashore. Routinely, VMM squadrons provide the foundation for an aviation combat element (ACE) of any level Marine Air-Ground Task Force (MAGTF) mission that may include conventional assault support tasks and special operations."[8] Anything that affects a VMM causes ripple effects for the entire Marine Corps.

Marine Aircraft Group: Commanded by a colonel, this is the next larger unit that generally has six aviation squadrons it is in charge of along with a logistics and air control squadrons. The MAG receives personnel from Manpower and Reserve Affairs and then distributes them to the squadrons to meet T/O priorities. MAG-26 is the MV-22 model manager. It is solely in charge of VMM squadrons and one Marine Aviation Logistics Squadron (MALS) supporting those VMM squadrons. Being the model manager for a specific aircraft means you set the practices to be implemented throughout the fleet for other squadrons of that same type of aircraft.

Marine Aircraft Wing: Commanded by a major general, the MAW is in charge of all aviation for its associated Marine Expeditionary Force. The 2nd MAW is in charge of all Marine Corps aviation on the east coast; 2nd MAW is in charge of four MAGs and is in charge of additional aviation support units. The aviation TYCOM for MV-22s is located at 2nd MAW.

[8] Marine Aircraft Group 26, "The Mission of VMM."

Marine Aviation Logistics Squadron: Commanded by a lieutenant colonel, the MALS is responsible for suppling aviation squadrons with aircraft parts and maintenance capabilities that are not available at the unit. MALS also develops the aircraft transfer plan, which dictates when and what aircraft will be assigned to each squadron. MALS presents the aircraft distribution plan through MAG to the aviation type commander (TYCOM) located at the Marine Aircraft Wing (MAW) for final approval.

Sortie Generation: Sortie generation is a term used in the aviation community that encompasses all facets of the process that leads up to flying aircraft. According to Joint Publication 3-30, *Command and Control of Joint Air Operations,* a sortie is defined as, "In air operations, an operational flight by one aircraft."[9] A squadron needs to conduct sorties in order to train its aircrew and complete missions. The training and readiness program for the MV-22 states that the average length of a sortie is 1.5 hours.[10] A sortie can be a 10-minute flight or a 6-hour flight. For the purposes of this study, sortie generation is focused primarily on the ability for MAG-26, MV-22 squadrons to perform training flights in CONUS. An aircraft that can conduct any of its assigned missions is called a full mission capable (FMC) aircraft. An aircraft that has some degraded or broken components but is able to fly safely is called a partial capable aircraft (PMC). The MC rate of a squadron is the number of FMC plus PMC aircraft usually described as a percentage. If a VMM unit is 50 percent MC then it would have six planes that are able to

[9] Joint Chiefs of Staff, Joint Publication 3-30, *Command and Control of Joint Air Operations* (Washington, DC: Government Printing Office, 2014), GL-9.

[10] Commandant of the Marine Corps, NAVMC 3500.11D, *MV-22B Training and Readiness Manual* (Washington, DC: Department of the Navy, Headquarters U.S. Marine Corps, 24 October 2014), 1-5.

fly, assuming it has twelve aircraft assigned. Ready based aircraft (RBA) is an aircraft that is MC and not in a test status. Depending on the type of maintenance conducted, an aircraft will have to undergo a test flight prior to being released for training or operational flight. An aircraft can be MC but non-RBA. For example, even though a squadron may be 50 percent MC it could have two planes that need testing, therefore only four planes are RBA and available to generate training or operational sorties. The ability to repair and fly aircraft is called sortie generation. The more efficient a squadron is at generating sorties the better it can train pilots and maintainers. Parts, qualifications, weather, personnel, holidays, and ground training all effect sortie generation.

Limitations

There is a lack of concrete information on why a USMC squadron has the number of aircraft that it does. A number of decisions for the MV-22 were based on assumptions that it would be a direct replacement for the CH-46. As such, many T/O, T/E, employment, and deployment decisions were copied and pasted from CH-46 doctrine, with no substantiating evidence.

Aircraft transfer data is incomplete. Tracking of aircraft transfers by X-ray maintenance action forms on DECKPLATE does not reveal the full inventory of transfers. Therefore, aircraft transfers were tracked and data was pulled from MALS, TYCOM, and the Automated Message Handling System (AMHS).[11] No organization has

[11] A bureau number is a specific serial number for an aircraft. It is equivalent to a car's vehicle identification number. Each aircraft bureau number is unique and never changes.

a formal historical tracking system. AMHS only retains records for the previous three years.

Scope and Delimitations

The scope of this paper is limited to MAG-26. MAG-26 is the MV-22 model manager and has had MV-22s the longest of any of the MAGs. Since Aviation Management Supply and Readiness Reporting (AMSRR) data is not compiled in a historic repository like DECKPLATE it was not used for this study. AMSRR traditionally reflects higher MC rates than Optimized-Organizational Maintenance Activity (OOMA)[12] data. CV-22 data was not used for this study because the Air Force utilizes a different organizational construct. The Air Force utilizes separate squadrons for maintenance and flying, unlike the Marine Corps where it is combined. In addition, the Air Force deploys as detachments vice entire squadrons, and utilizes a different supply prioritization than the Marine Corps. For these reasons, the Air Force CV-22 community does not lend to organizational comparisons with the USMC.

Significance of the Study

The MV-22 community appears to be at a tipping point in its ability to support the current operational tempo. If the MV-22 community has trouble supporting its obligations, Marine manpower will be unable to assign MV-22 personnel to job assignments outside the community.[13] A lack of personnel available to fill rotational

[12] OOMA is the interface/program that the individual unit uses to input and track all maintenance actions. OOMA data is uploaded to DECKPLATE.

[13] The MV-22 community was fenced up until 2014. The term fencing refers to its personnel being unable to be assigned duties outside of its primary occupational

billets will negatively impact other communities as more of their personnel are pulled to fill the increase in job assignments outside their primary duty. If there were a way to increase training sorties, which would allow for better-trained maintainers and aircrew along with increasing the dwell-to-deploy ratio and increasing retention in the MV-22 community, the Marine Corps would benefit immensely.

Conclusion

Tilt-rotor technology is a significant leap forward for employment of forces. This is an asset unlike the USMC has ever had before. For the USMC most decisions on how to employ and organize the MV-22 were based on what a CH-46 did, because that is what it was meant to replace. Ten years of operational deployments has shown the V-22 is not a replacement for a CH-46. It does some things better than the CH-46, some things worse than the CH-46, and some things no one imagined as a possibility. It truly is a force multiplier. However, it is still being operated as a legacy platform in both asset allocations and force structure. If there is a better way to assign, maintain, and employ the unit, it will usher in a new evolution of capabilities for the Marine Corps.

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specialty. Even though the MV-22 community is officially unfenced it is not treated like other communities and does not regularly allow personnel to participate in jobs outside the community due to operational necessity.

CHAPTER 2

LITERATURE REVIEW

The purpose of this study is to analyze the current organizational make up of a MV-22 squadron in order to determine if a change in size and composition would result in an increased ability to fly aircraft, train personnel, and increase deploy-to-dwell time. The focus of this thesis will be on three topics: maintenance data, dwell-to-deploy data, and MV-22 squadron design.

MAG-26 Maintenance Data

All maintenance data is uploaded to the Navy's DECKPLATE historical repository server. Access to the DECKPLATE program can be requested via https://prdwebserv9.navair.navy.mil/. When a squadron goes on a detachment or deploys where there is minimal bandwidth a standalone server is utilized to collect all maintenance data. On a monthly basis, the data is copied onto a disk and mailed to DECKPLATE to be uploaded and synced into the online maintenance server. MAG-26, the type model manager for MV-22s, has a current readiness shop that compiles all maintenance data for briefings to MAW and Headquarters United States Marine Corps.

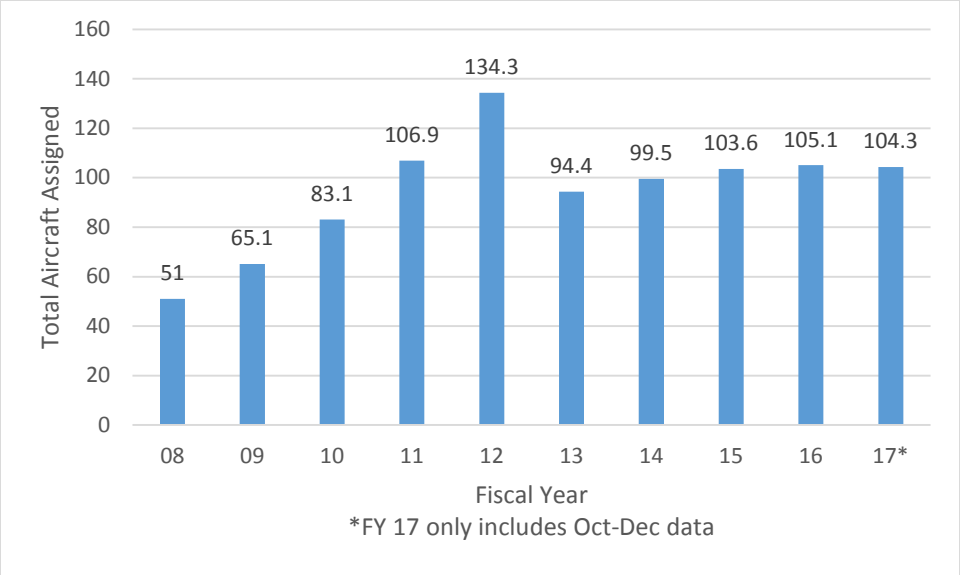

Figure 1. Aircraft Assigned to MAG-26

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

As VMM squadrons evolved, the number of aircraft in New River grew and eventually all VMM squadrons at New River became consolidated into MAG-26. MAG-26 is a single type aircraft MAG and the MV-22 model manager for the USMC. The peak number in 2012 was a result of the plan to shift established assets from MAG-26 to the west coast for the creation of more operational VMM Squadrons. The number of aircraft has stabilized in MAG 26 at around 104.

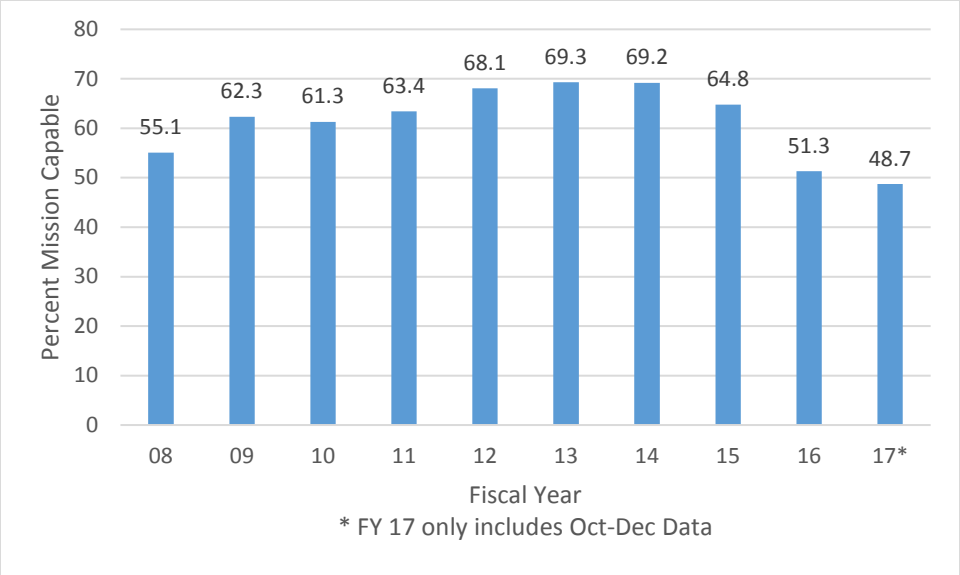

Figure 2. MAG-26 MC Rates by FY

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

MC[14] is the ability for an aircraft to fly and an indicator of aircraft readiness. MC does not necessarily mean the aircraft may fly missions or training flights but it is airworthy. RBA[15] is a better indicator for when an aircraft is ready and capable to fly

[14] Commander, Naval Air Forces, COMNAVAIRFORINST 4790.2C, *Naval Aviation Maintenance Program* (San Diego, CA: Department of the Navy, 15 January 2017), Appendix A. Mission Capable (MC) - Material condition of an aircraft indicating it can perform at least one and potentially all of its designated missions. MC is further defined as the sum of full mission-capable and partial mission-capable.

[15] Ibid. A Ready Basic Aircraft is the minimum configuration required to conduct day or night instrument meteorological conditions flight operations with necessary communications, identification friend or foe, navigations, flight and safety systems required by applicable naval air training and operating procedures standardization and federal aviation administration regulations. This aircraft does not require a Functional Check Flight and does not require shipboard operations equipment.

missions or training. An aircraft can be MC but not RBA, for example, it just completed maintenance that requires a test flight before being able to conduct missions or training. From inception, one would expect a gradual increase in MC rate followed by period of leveling off. As the VMM community grew, it would gain experience in what parts break, how to fix them, what parts need to be in stock, troubleshooting, and then the community would reach a steady state of readiness with maturity. The VMM community began along the projected MC rate increase, but then readiness fell significantly. Starting in 2008, MAG 26 had a MC rate of 55.1 percent. There was a steady increase until Fiscal Year (FY) 13 and 14, which plateaued at 69.3 percent and 69.2 percent respectively. Then in FY15 the MC rate dropped to 64.8 percent and then to 51.3 percent in FY16; finally, its sits at 48.7 percent for the first three months of FY17. The program of record states that VMMs should be at 82 percent[16] readiness in order to provide enough aircraft available to meet the training and operational demands.

[16] Contact with Headquarters Marine Corps Aviation Division revealed the V-22 Block C/20 Capability Production Document states in 13.1 Logistic/Material calls for: Availability: A MC rate equal to or greater than 82 percent at system maturity (60,000 hours) is required (Threshold), 87 percent (Objective). Rationale: In order to provide sufficient MC aircraft to perform assigned missions as identified in the cost and operational effectiveness analysis.

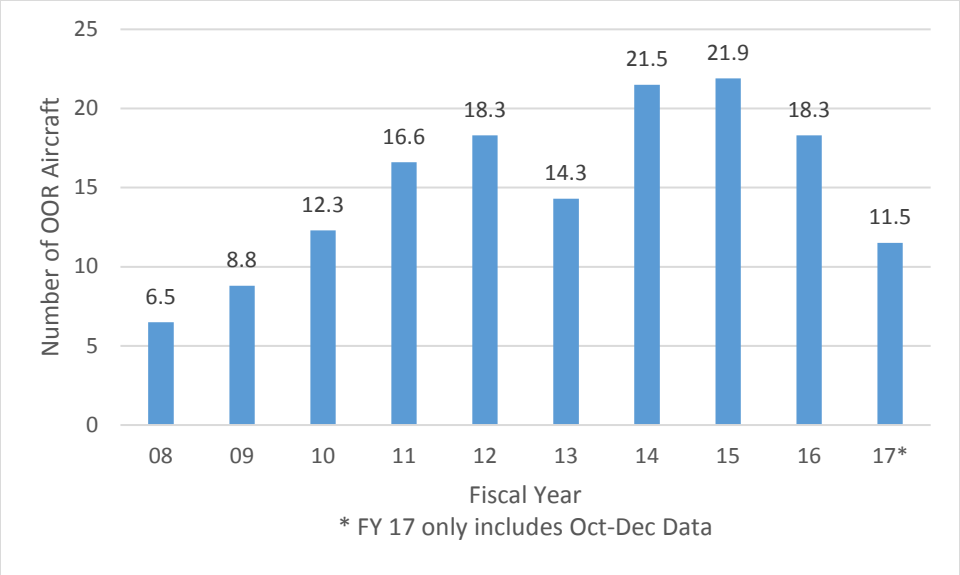

Figure 3. Average Monthly OOR Aircraft

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

Out of Reporting (OOR) is a maintenance reporting classification that aircraft are put in if they meet certain requirements for repair. If an aircraft needs repair at a depot level facility, it will be placed on OOR. That allows the squadron not to count that aircraft in its MC or readiness calculations. For example, if a squadron has its full complement of twelve MV-22s and it has two aircraft OOR, with seven planes MC it will have a MC rate of 70 percent instead of 58 percent. It is a way to not penalize the squadron's maintenance department for repairs that it cannot conduct while waiting on depot or equivalent level repair to be conducted. However, starting in FY16 the

requirements to place an aircraft on the OOR list became more restrictive.[17] The new rule governing classifying an aircraft as OOR was that it had to actually be in depot-level repair vice waiting for repair. This is significant because now planes that may have been OOR for weeks or sometimes months, waiting on a five day repair, would only be OOR for those days of actual the repair. As a result of the OOR status being more restrictive, MC rates are more representative of what the fleet is actually like and average OOR numbers fell. Before the rule change in mid-2016, MAG-26 had over 20 percent of its MV-22s OOR during FY 14-15. In FY16, it dropped to 18.3 percent and 11.5 percent for the beginning of FY 17.

[17] *Aviation Maintenance Advisory* 2016-13 implemented guidance that prior to an aircraft being placed in Out of Reporting (OOR) status it would need to have engineering approval that the repair would take over 120 days. However, if the engineer did not state that it would take over 120 days to repair then it would only be placed in OOR during the repair. Rarely does an engineer know the timeline for a repair and is unwilling to sign his or her name to a repair taking longer than 120 days. As a result, aircraft have remained in reporting and even go beyond the 120-day waiting to be repaired. An explanation of the 120-day requirement is now in Commander, Naval Air Forces, COMNAVAIRFORINST 4790.2C, ch. 5.3.5.2.a.

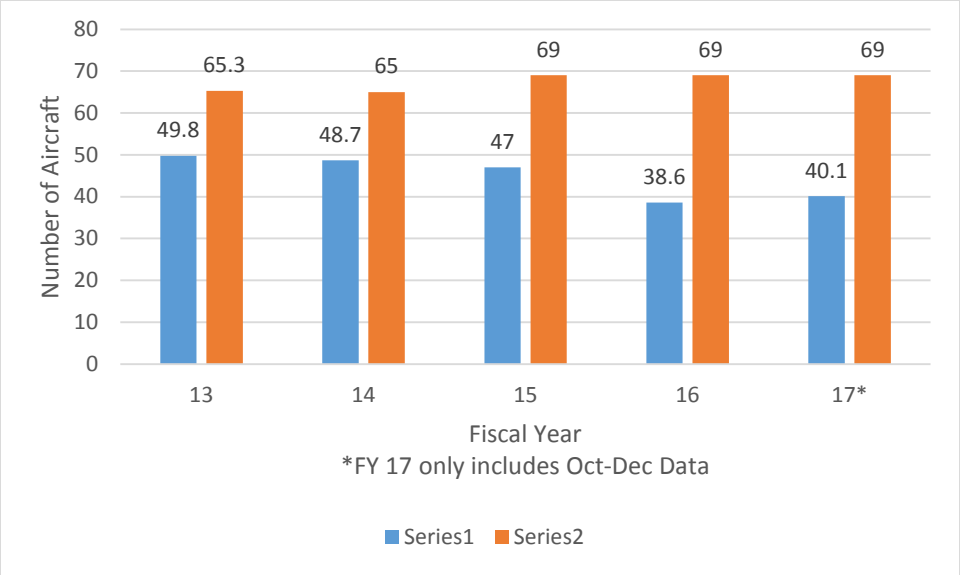

Figure 4. RBA versus RBA Goal

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

RBA is a MC aircraft that is ready to be assigned to a training or mission flight. Each VMM has an RBA goal. For MAG-26 it is 75 percent of its aircraft. MAG-26 has never reached its RBA goal. It had the most RBA during FY 13 and 14, and then began to see a decrease in the following years. This RBA deficiency makes it difficult for units to train its squadron personnel and forces more hours to be flown on fewer aircraft. The overall maintenance program is based on equal use of the aircraft, and spreading out the hours over all the aircraft. Imagine you had nine vehicles to run a business, but you regularly have only five or six that run. Those five or six vehicles would be utilized significantly more than you had planned and they would need maintenance more often, things like oil changes, engine overhauls, transmission rebuilds, brake jobs, etc. The same

is true for aircraft reaching scheduled maintenance intervals quicker than planned; this creates an increased demand on maintenance and the supply system.

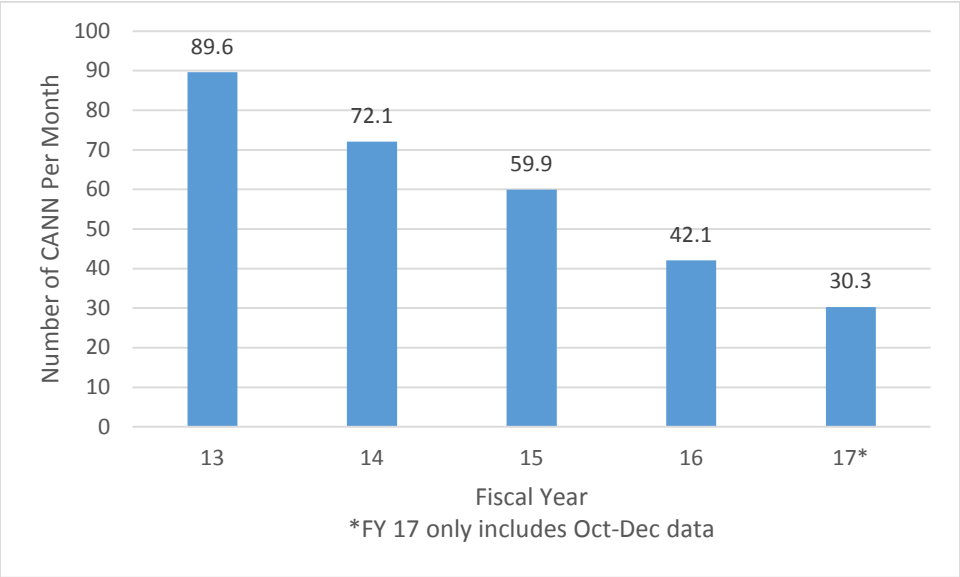

Figure 5. Average Monthly CANN Rate

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

CANN is an acceptable practice outlined in OPNAV 4790, the maintenance publication governing how to conduct naval aviation maintenance. When a part is not available in the supply system, the unit may decide to CANN a part from one aircraft and install it on another aircraft to make it MC while waiting for the part from supply. CANNs are a stopgap to fix an enduring problem of not having enough parts readily available. If an aircraft is long-term down, meaning it has not flown in twenty-one days, then the unit may only CANN a part from that plane with sing-level approval (TYCOM);

otherwise, it is up to the squadron maintenance department. TYCOM approval for CANNing from long-term down aircraft is an effort to avoid having aircraft that become repair part donors, and are never reassembled for years. There have been MV-22s in MAG-26 that have flown for years. CANNing is a work around to increase MC aircraft but has negative effects on morale and maintenance man-hours. If a part was in the supply system it is ordered, the broken part is removed and when the new part is received, it is installed. Each CANN results in at least double the maintenance repair actions. A CANN is conducted when a suitable part is not readily available. To CANN, maintenance removes the broken part from the first aircraft. Since no replacement part is available that part is removed from a second donor plane and installed on the first plane. Since the broken part was not available, there is still a hole on the second plane that now needs maintenance when the part becomes available. A part may be continuously CANNed from one plane to the next as aircraft continue to break or go into scheduled maintenance for extended periods, i.e. a third plane gives up the part to go into the second plane, and then a fourth plane in turn gives up the same part to go into the third plane. The positive trend in MAG-26 of reduced CANN numbers is recognition that CANNing should not be the first option to make an aircraft MC; it also should not be used as a cover for an inability of supply to keep up with demand. Many times, it is industry that cannot or will not keep up with demand and it has nothing to do with the military supply system. CANNing does make MC rates go up; however, it hides demand for parts; this means the parts supply problem is not addressed.

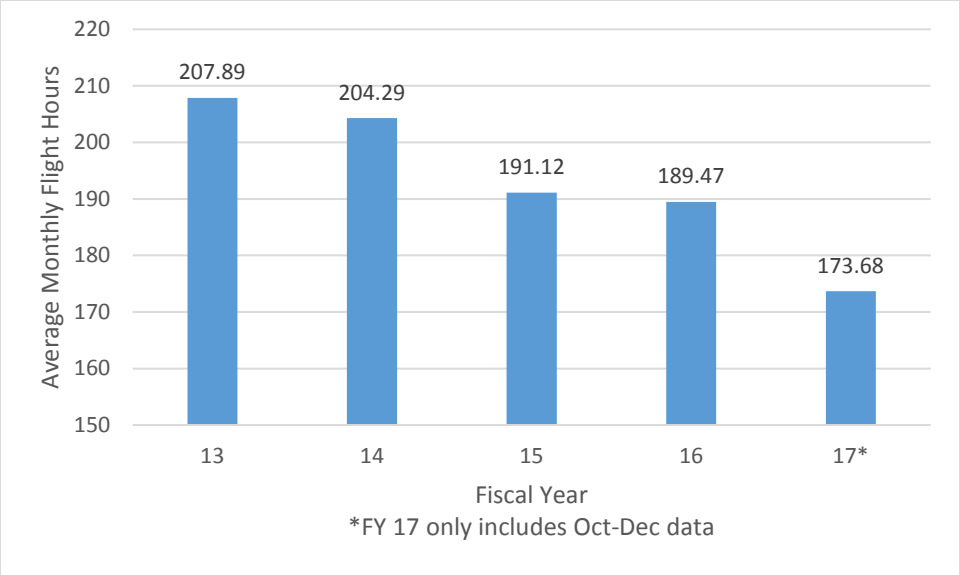

Figure 6. Squadron Monthly Flight Hours

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

Since FY 13, there has been a steady decrease in monthly flight hours for MV-22 squadrons in MAG-26. This is primarily due to the decrease in MC rate; however, some of it is due to the nature of its current deployments. MEU's vary widely in their flight hours depending on if they are tasked with a pop up mission or if they remain on the boat and only conduct training. OEF had the largest impact on flight hours in FY 13 before it became a standby casualty evacuation mission in FY 14 and then was no longer a MV-22 mission. SPMAGTF-CR-AF is also a stand-by mission. The unit's mission is to stand by and be on alert to launch anywhere in United States Africa Command within six hours. As a result, it is not conducting battlefield circulation or general support as it was in OEF or OIF and deployed flight hours have decreased. In order to remain safe and proficient in

flying, II MAW has mandated a minimum of fifteen hours per month of flight time per pilot.[18] For a VMM squadron there are twenty-eight pilots, each pilot requiring fifteen hours of flight time per month. Since there are two pilots per aircraft, multiply twenty-eight times fifteen, then divide it by two to get the absolute minimum to get fifteen hours per month per pilot in perfect flight sharing of hours, this results in 210 hours of flight time. MAG-26 is currently unable to meet this requirement and is relying on the simulator to reach and maintain fifteen hours of flight time a month. The MV-22 simulator is an excellent machine; however, it will never replace the experience that comes with flying the aircraft. Nothing can replicate the tactile feel of how the plane moves through the air; the decision making process that comes with actual emergencies where consequences are more than just resetting the simulator, or the involvement of the crew and not just a co-pilot.

[18] Commanding General, 2d Marine Aircraft Wing, II Marine Expeditionary Force, Wing Order 3710.38C, *Standing Operating Procedures for Flight Operations in 2d Marine Aircraft Wing* (Cherry Point, NC: U.S. Marine Corps, 19 March 2014), para. 1201 2B.

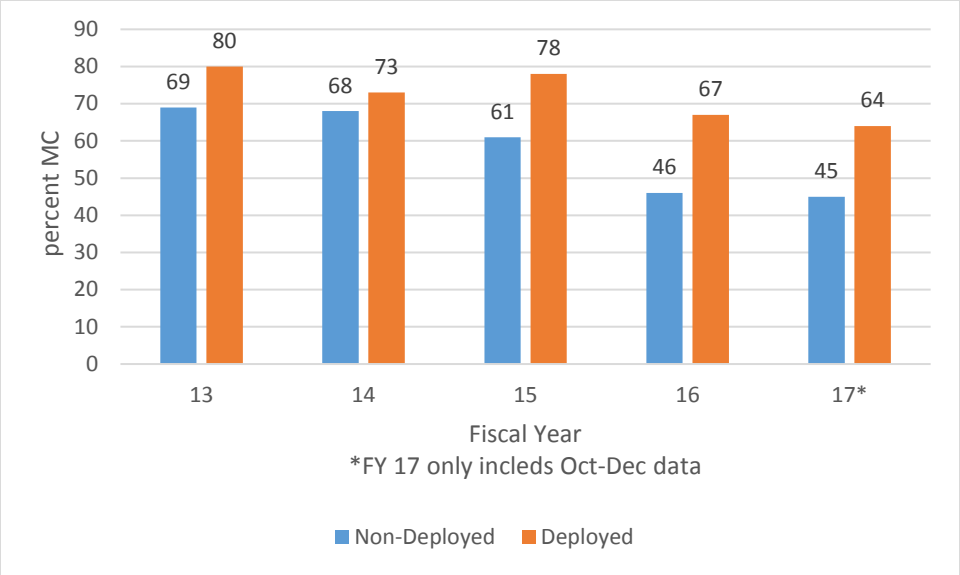

Figure 7. Average MC Rate for Non-deployed versus Deployed Squadrons

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

MC rates have been decreasing since FY 13. Non-deployed units have been affected most, due to a lower priority for parts than deployed units have. The aircraft has not been able to be maintained at the rate required to generate adequate flights to maintain the current operational and training demands. Before the fall of 2016 if a squadron was below 50 percent MC, they had to receive approval from the MAG commanding officer to conduct operations. However, because of the state of the aviation community that threshold for approval has been reduced to 75 percent of the aviation plans RBA goal. For a MV-22 squadron of twelve aircraft that would be 75 percent of

seven RBA aircraft. Five RBA aircraft is now the minimum RBA prior to MAG commanding officer permission to fly.[19]

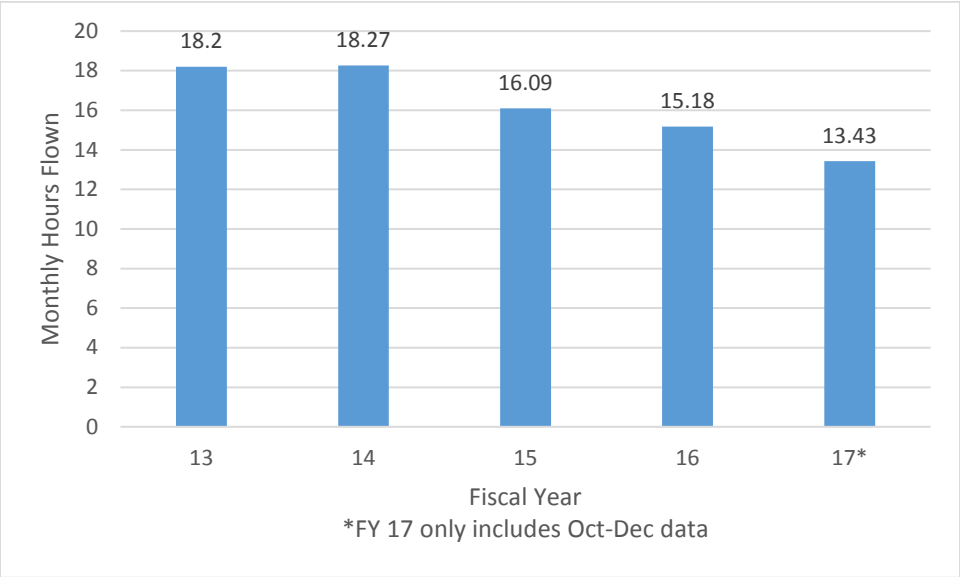

Figure 8. Monthly Aircraft Utilization Rate

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

Aircraft utilization rate is the average monthly hours flown on an aircraft. The higher the number the more stress is being put on each aircraft. Although MC rates have decreased significantly, it is only due to the simultaneous significant decrease in flight hours that the utilization rate has also gone down. For FY 17 the utilization rate will

[19] Commanding General, 2d Marine Aircraft Wing, II Marine Expeditionary Force, Wing Order 3501.4F, *Aircraft Readiness* (Cherry Point, NC: U.S. Marine Corps, 14 September 2016), 28, para 1404.1.

likely rise as the year progresses. October, November, and December are traditionally lower flight hour production months due to holidays.

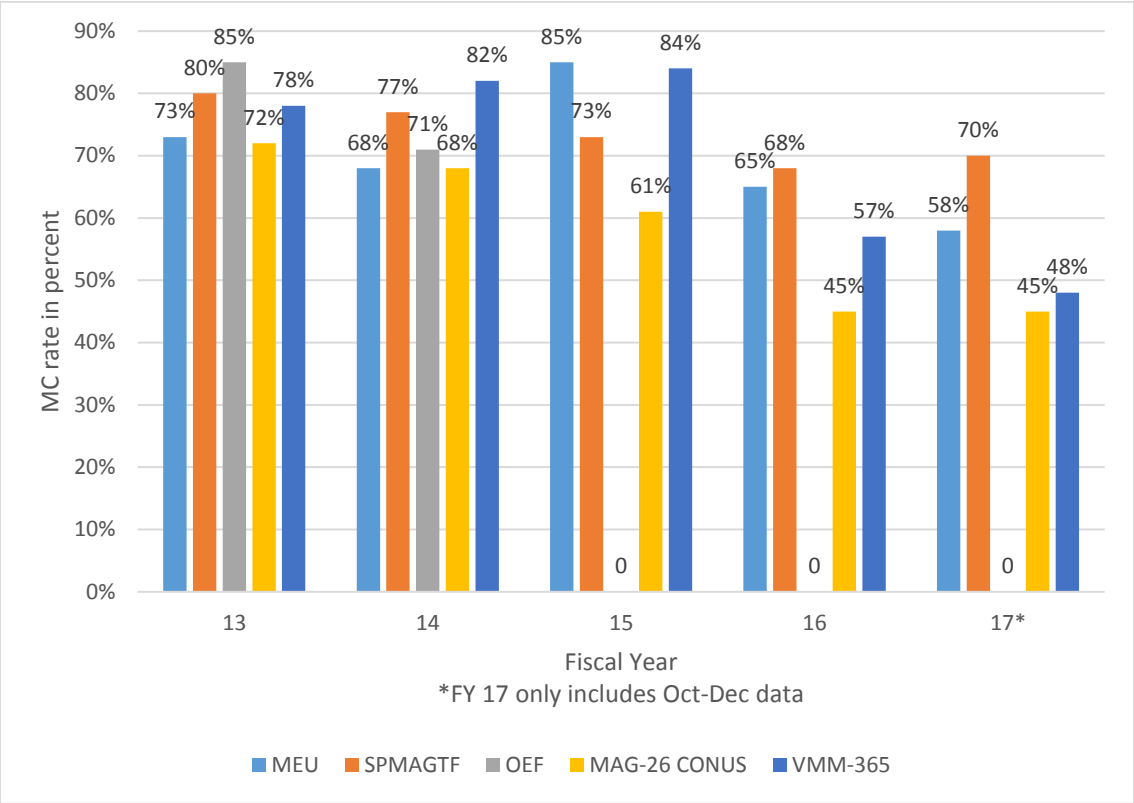

Figure 9. MC Rate by Location

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

During FY 13 and FY 14 MAG-26 was supporting OEF, SPMAGTF-CF-AF and a MEU. OEF, SPMAGTF, and the MEU are all Force Activity Designator (F/AD)-2 status for parts and have a full complement of qualified Marines to fly and fix the aircraft because they are deployed. Conus based squadrons are F/AD-3, have families, holidays,

weekends, additional annual training and are constantly turning over qualified individuals to new tours and receiving unqualified individuals to train for the next deployment, which effect the MC rate. Support of OEF stopped after 2014 when all MV-22s were flown from Afghanistan to Kuwait for the creation of SPMAGTF-CR-CENTCOM, which is supported by personnel from the west coast MAGs. Land based deployments such as OEF and the SPMAGTF generally have the highest MC rate due to the high parts priority, fully qualified manning and space to conduct maintenance twenty-four hours a day, seven days a week without distractions. Although the MEU also has fully qualified maintenance personnel and the same parts priority as a land based deployment, it is generally a lower MC rate due to the restriction of operating with the Navy and with limited space to conduct maintenance on the ship. Light restrictions, roll and pitch, quiet hours, qualified tow personnel, mess hall hours, internet connectivity to log and record maintenance are all limitations to the MC rate while operating with the Navy. CONUS based aircraft have the lowest MC rate, due to the constant turnover, transfers of aircraft, lowest priority for parts, and constant distractions of a non-isolated life.

VMM-365 is broken out because it was unique in the limited number of aircraft it transferred between FY 13 and FY 16. In FY 13, it created the SPMAGTF-CR-AF and supported it with only a .5 squadron so half of the squadron was still CONUS based at MAG-26. This allowed it to keep at least half of its aircraft and prevent them from being transferred. When the other half of the unit returned, they only had to accept another half of a squadron's worth of aircraft to be operational. Then VMM-365 had two back-to-back MEU deployments where they kept their planes allowing them to develop a sense of ownership and groom the planes for long-term health. Squadrons conducting OEF or

SPMAGTF deployments have to transfer all their planes before deployment, accept a full complement of planes when arriving in country and then transfer those planes to the replacement squadron and accept a whole new squadron of planes when returning CONUS to MAG-26. The effects of only temporarily having aircraft in CONUS can be seen in the MC rates of MAG-26 CONUS.

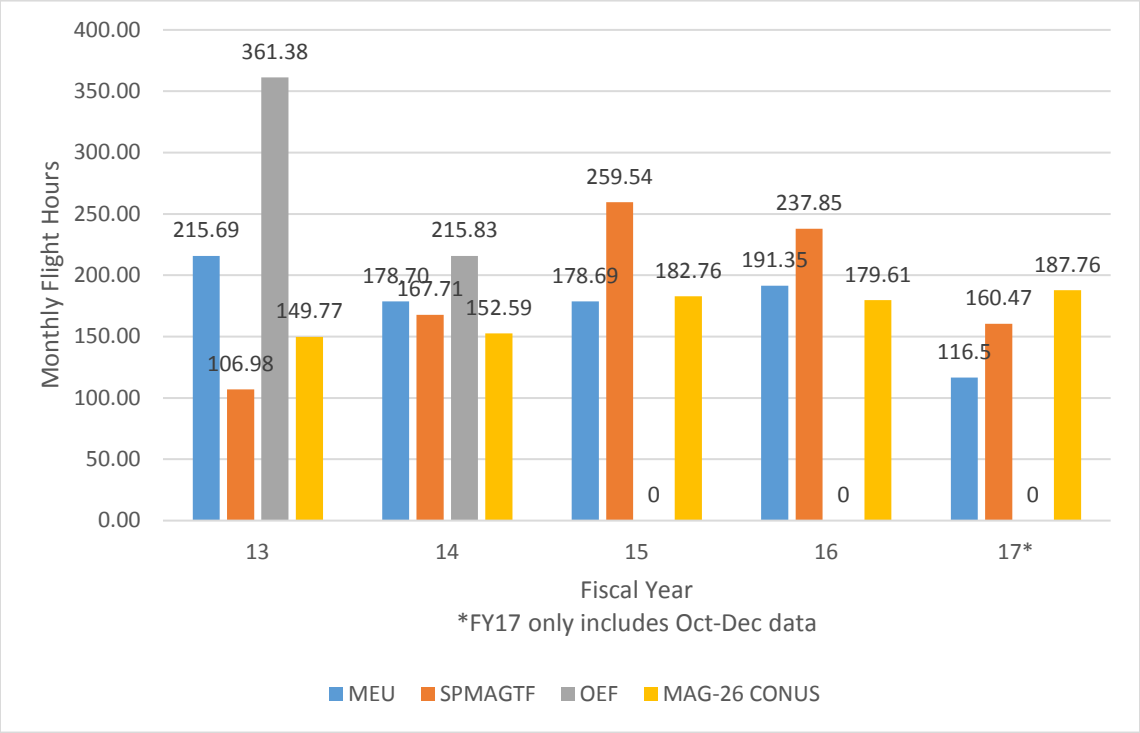

Figure 10. Average Monthly Flight Hour Production by Location

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

Similar to MC rate, land based deployed squadrons have higher monthly flight hours due to mission requirements and the ability to support with more parts available,

fully qualified maintainers and a resulting higher MC rate. In FY 13, one month was truncated from the data due to only a partial month of flying before a west coast unit took over responsibility for the mission. Starting in FY 14 OEF went from a general support mission to solely a casualty evacuation stand-by mission and the hours of tasking dropped off dramatically. In fall of FY 14, the OEF squadron self-deployed from Afghanistan to Kuwait to set up the SPMAGTF-CR-CENTCOM so its average hours were able to increase slightly due to the transit. MEU's are a mixed bag for flight hours, if there is a crisis they get significantly more hours, if not they train and have limited opportunities to fly due to the ships schedule. In FY 14, the SPMAGTF-CR-AF increased to a full squadron and has remained a full squadron. Plans are to reduce the SPMAGTF-CR-AF to half a squadron in FY 17. As MC rates have generally decreased over the last four years, demands to train and prepare for deployment have not decreased. As a result, this has put an ever-increasing strain on the ability of squadrons to maintain and increase the ability to train with decreasing aircraft available.

VMMT 204 Data

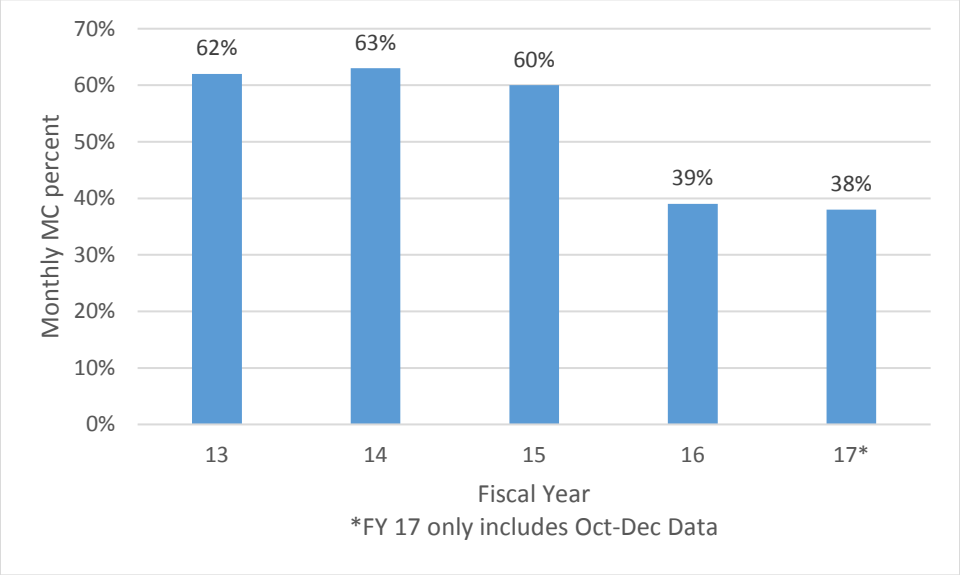

Figure 11. VMMT-204 Average Monthly MC Rate

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

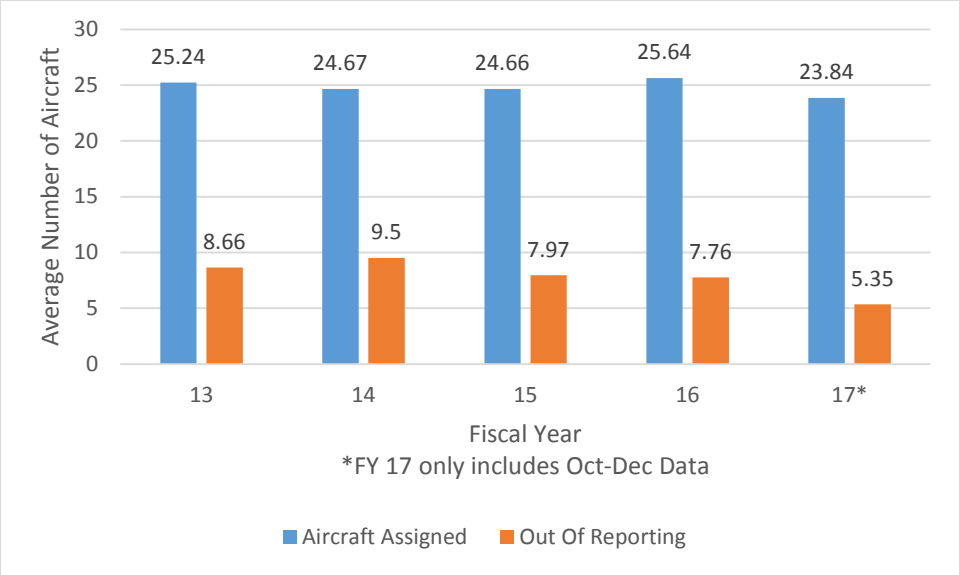

Figure 12. VMMT-204 Average Aircraft Assigned versus OOR Aircraft

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

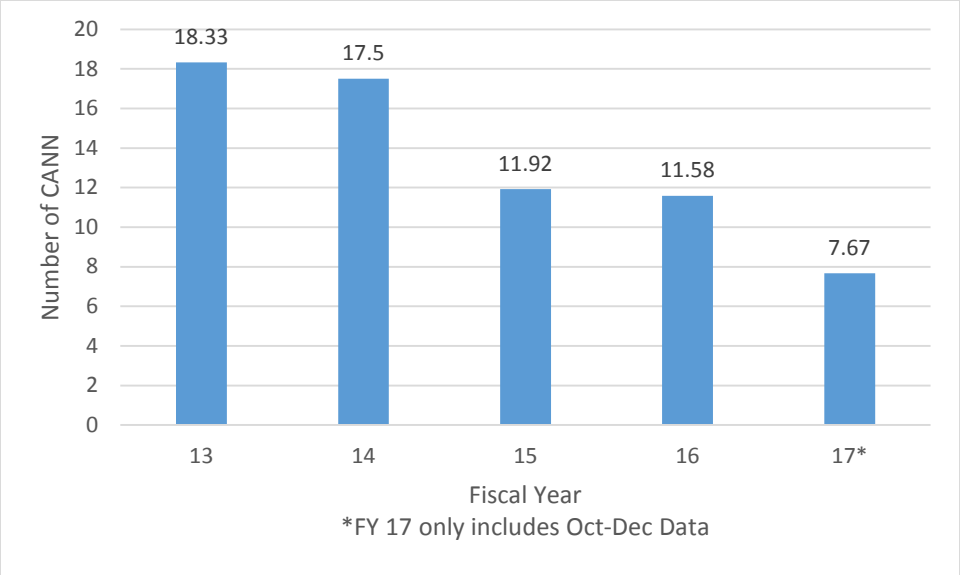

Figure 13. VMMT-204 Average Monthly CANN

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

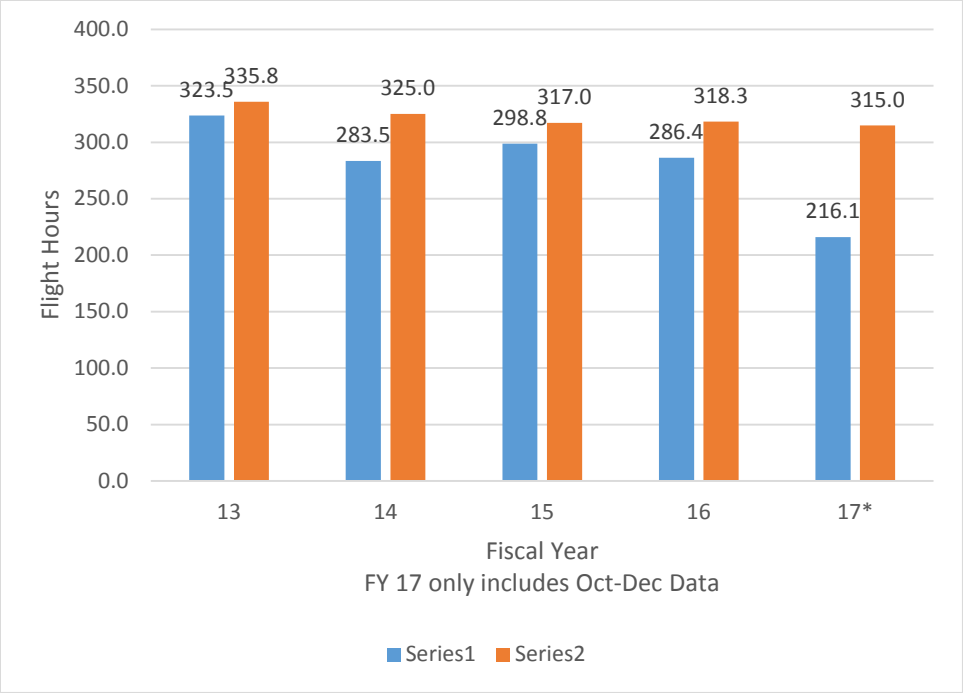

Figure 14. VMMT-204 Average Executed versus Planned Flight Hours

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

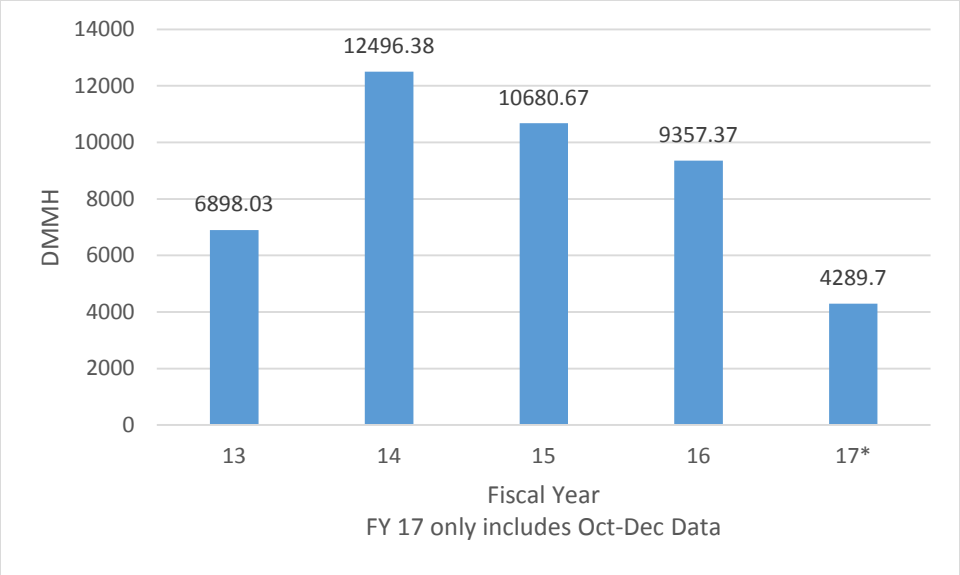

Figure 15. VMMT-294 Monthly Discrepancy Maintenance Man-hours

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

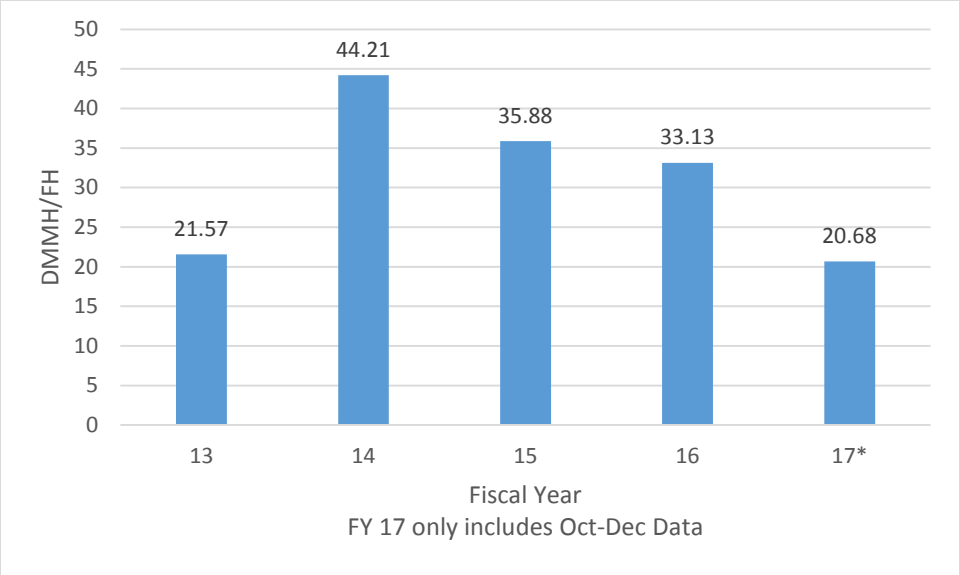

Figure 16. VMMT-204 Discrepancy Maintenance Man-hours per Flight Hour

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

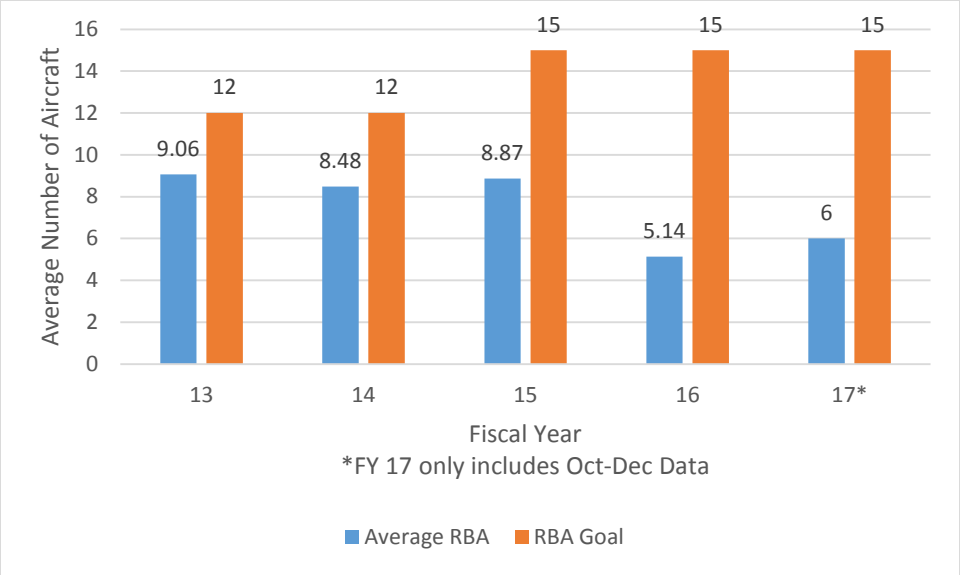

Figure 17. VMMT-204 Average RBA versus RBA Goal

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

VMMT-204 is the Fleet Replacement Squadron (FRS) for MV-22s and assigned to MAG-26. The FRS is responsible for all initial MV-22 pilot training for the Marine Corps and the Air Force along with refresher training for MV-22 pilots who have been out of the cockpit for greater than 485 days. The FRS is also tasked with training the initial Japanese pilots and Navy pilots starting in FY 17. The FRS does not deploy and perpetually remains F/AD-3 for parts. The FRS is as close to a baseline for true maintenance and flight hour production as one can get. The difference that the FRS has versus operational squadrons is that it has permanently assigned contract maintainers, which has continued to increase in size and scope and currently sits at thirty-five contract personnel to assist in maintenance. The FRS has block A and block B aircraft while

operational squadrons have block B and C. The block A aircraft are the oldest aircraft and have some maintenance tasks that require more man-hours than newer models due to the panel configuration. Future plans are for the FRS to shed all its block A aircraft to operational units to hopefully improve its flight hour production. However, operational units fly in more austere conditions thus causing more wear and tear on aircraft components than the FRS experiences.

Manning Data

The primary resource for manning data for officer and enlisted is through Marine Manpower and Reserve Affairs division in Quantico, VA. Secondary sources are the MAG Personnel Support Detachment (PSD) commanding officer. The MAG PSD resources officers to squadrons after manpower assigns them to the MAG. Additionally at the MAG level the MAG maintenance chief acts in the same manner as the PSD commanding officer for allocating enlisted manpower.

The rotary wing monitor for field grade officers, at Manpower and Reserve Affairs, is responsible for field grade personnel in the MV-22, CH-53, AH-1, and UH-1 communities. Through discussions with the monitor, it was discovered that USMC aviation is manned at 97 percent of its staffing goal.[20] However, the MV-22 community is only at 68 percent staffing goal, 73 percent for field grade, and 65 percent for company grade offices.

[20] Staffing goal is determined by Manpower and Reserve Affairs. It varies by needs of the Marine Corps and can be an increase over T/O or decrease below T/O.

Dwell-to-Deploy Ratio

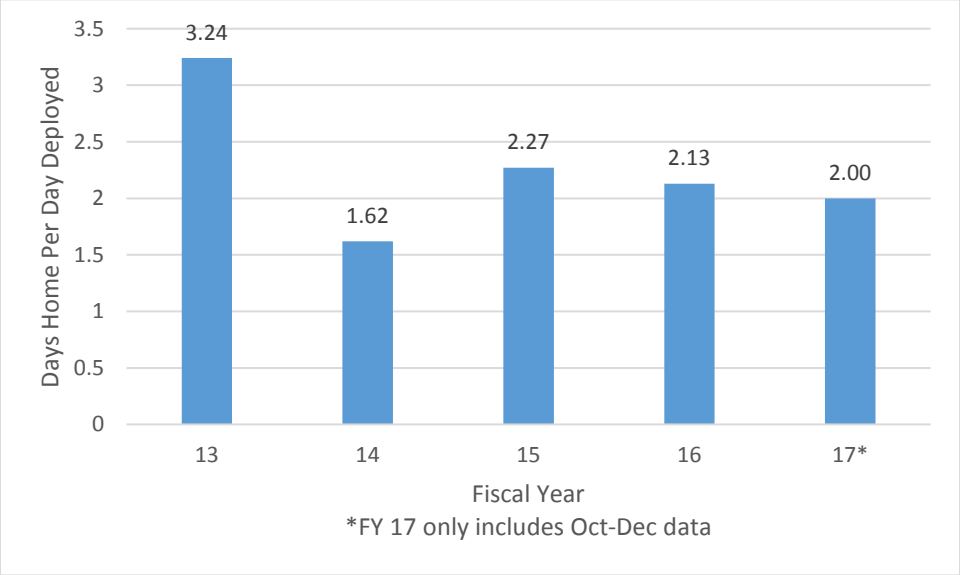

Figure 18. MAG-26 Dwell-to-Deploy Time

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

Marine Corps Administrative Message 346/14, Subject: Deployment-to-Dwell, Mobilization-to-Dwell Policy Revision, defined the dwell-to-deploy ratio from the Secretary of Defense. The minimum ratio desired is 2:1, meaning one day deployed to every two days not deployed. For example if you went on a six-month deployment, you should be home for twelve months before deploying again. Any unit deploying under a 1:1 ratio requires Secretary of Defense approval. Deploy-to-dwell time is a ratio that compares units' days deployed verses days not deployed. MAG-26 went below the required number in FY 14 due to supporting OEF, a MEU, and increasing the

SPMAGTF-CR-AF from half a squadron to a whole squadron requirement. With OEF concluding in FY 14, deploy-to-dwell time began to level off. Starting mid FY 17, the SPMAGTF-CR-AF will be reduced to a half-a-squadron requirement in an attempt to improve the deploy-to-dwell ratio. The lower the deploy-to-dwell ratio the harder it is to retain personnel and train new personnel. Additionally, increased deployments put an increased strain on the supply system. Each deployed unit has a higher priority and greater need for repair parts. As more units deploy, that potentially leaves fewer parts and equipment available for non-deployed units. With the overall demands on the fleet, critical skill shortfalls are becoming a reality.

Aircraft Transfers

It has been difficult to ascertain the exact number of transfers of aircraft within MAG-26 even though there is an aircraft transfer message released for each transfer. The message system only keeps records for the previous three years, using DECKPLATE X-ray maintenance action forms is incomplete and convoluted to discern. Discussions with the MV-22 class desk revealed there is a definitive record of fifty aircraft transfers of MV-22s within MAG-26 in January through March of 2017. In 2016 and previous years Wing had Aircraft Transfer Orders (ATO) authority so records become incomplete. There is proof of forty-five transfers in 2016, though that number is more likely in the sixty to seventy range due to incomplete ATO's for the SPMAGTF-CR-AF. Previous to that, it becomes conjecture but experience has shown the number to be significant.

Requirement Based Design of a MV-22 Squadron

The organizational design of a Marine Corps unit is based on requirement-based capabilities to perform a mission. The mission of a MV-22 is "Provide assault support of combat troops, supplies and equipment during amphibious operations and subsequent operations ashore. Routinely, VMM squadrons provide the foundation for an aviation combat element (ACE) of any level Marine Air-Ground Task Force (MAGTF) mission that may include conventional assault support tasks and special operations.[21]" Through discussions with the Headquarters Marine Corps Aviation plans and policy, Marine Corps History Division, Marine Corps Doctrinal Command, and telephone conversations with former VMM commanding officers, no published reason was found stating why twelve aircraft are needed for a VMM squadron to accomplish its doctrinally assigned missions. The consensus is that there were twelve CH-46s in a squadron and this was a direct replacement for the CH-46 so the same construct was accepted.

Why are there twelve CH-46' in a squadron? Discussions with the National Museum of the Marine Corps revealed the following historical facts:

> In the 1950s, a series of boards and study groups reviewed the required make up of Marine medium and heavy lift squadrons and determined the medium lift units would be assigned 15 to 24 aircraft. At that time, the standard medium lift helicopter was the Sikorsky HUS-1 (the UH-34D after 1962), the proposed number of aircraft per squadron varied from board to board and 5-year plan to 5-year plan based on the promises of replacement helicopters on the horizon and the budget realities of the time. The stated doctrinal goal at this time was to be able to lift an entire BLT (then roughly 500 Marines) in a single wave.[22]

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[21] Marine Aircraft Group 26, "The Mission of VMM."

[22] Kristy Benjamin, Aviation Curator, National Museum of the Marine Corps, Quantico, VA, e-mail correspondence with author, 29 July 2016.

In 1964, when the first CH-46As were introduced as the replacement for the UH-34D, each medium lift squadron allocated twenty-four aircraft. This number drops to twenty-one aircraft in 1969, again from pressure from the Chief of Naval Operations to alter the mix of medium to heavy lift aircraft to find the most cost-effective ratio (i.e., to get down to the fewest number of airframes required as funding for the war in Vietnam was dropping).[23]

Following 1969, it begins to become conjecture as to how it dwindled down to twelve aircraft per squadron. Educated guesses are aircraft losses and budgetary constraints.

The design of T/O runs parallel to the thought process of aircraft assigned. If it worked for a CH-46 squadron, it is a good place to start for the MV-22 squadron. As a result, the T/O has recently been modified and is set to take effect later this year to better support the operational utilization of the VMM squadron, but still reflects legacy-manning holdovers.

[23] Benjamin.

CHAPTER 3

RESEARCH METHODOLOGY

The purpose of this study is to analyze the current organizational make up of a MV-22 squadron in order to determine if a change in size and composition would result in an increased ability to fly aircraft, train personnel, and increase deploy-to-dwell time. The qualitative method of research is used in conducting the analysis. The approach applied is designed to determine if there is a correlation in performance between the number of aircraft assigned to a squadron, if the squadron is deployed or non-deployed, and if the squadron has been transferring aircraft or keeping aircraft. Although nearly all of the research is quantitative in nature, in order to draw conclusions about what the data represents and how it interacts with each other, qualitative analysis is used.

Through the qualitative analysis process, the finding of facts are organized into three subjects in order to address the primary and secondary thesis questions. The first area is information that led to the current MV-22 squadron design. The second area is MV-22 squadron performance. The third area is the identification of possible shortfalls within the squadron organization.

In order to determine if changes in the organization are warranted, it is first necessary to understand the reasons behind the current organizational design. Answering questions such as is the design of the squadron based on operational requirements such as lift capacity or space available on naval amphibious shipping? Alternatively, is the squadron designed for sustained home based facilities, or simply on the legacy aircraft organization? Understanding the background for the organizational design impacts potential recommendations on how to improve current squadron organization.

In order to answer the questions posed in the previous paragraph, information was collected through the Marine Corps Historical Society, Headquarters Marine Corps Aviation, and Manpower and Reserve Affairs. Research in this area focused on information such as: the history behind the number of aircraft assigned to a squadron, squadron maintenance organization and manning, squadron aircrew assigned, and quantity of maintenance equipment assigned to a squadron. Once the background of the MV-22 squadron design is determined and understood, the next step is to research the performance of the squadron's current design.

The performance of a squadron can be summed up as the ability for the squadron to operationally fly the aircraft and the ability for the squadron to repair the aircraft. Through analyzing and interpreting the maintenance data from 2008 through December 2016, it is possible to make logical and repeatable conclusions about MV-22 squadron capabilities within MAG-26. Since all MV-22 maintenance actions are recorded and uploaded to DECKPLATE, the Navy online repository of maintenance data, information is readily available and can be referenced repeatedly.

Through careful analysis of the maintenance and aircraft performance data, it is possible to determine how the MV-22 community has been progressing and where it might logically be heading in the future. One of the common occurrences in the MV-22 community that has significant impact on squadron performance is the transfer of aircraft between squadrons. Information regarding aircraft transfers can be found on DECKPLATE but is incomplete and burdensome to assimilate; therefore, a different source was utilized.

It is possible to query aircraft transfers in DECKPLATE through maintenance action forms called X-rays. The preferred method to accurately track aircraft transfers is by manually searching the AMHS for ATO. Every aircraft transfer has to be authorized by the TYCOM, who then releases an ATO message via AMHS to the MV-22 fleet. Unfortunately, AMHS only retains information for three years. Therefore, accurate aircraft transfer information beyond the previous thirty-six months is incomplete.

With the background on the current MV-22 squadron design and its present and past maintenance performance, the qualitative process is utilized to identify shortfalls. The MV-22 community is still growing, acquiring new aircraft capabilities, and being utilized is more missions than ever. Because of this growth and continued evolution, the current shortfalls and subsequent solutions described in chapter 5, will not solve every issue the community faces. Additionally, the use of a different methodology may identify different shortfalls or the importance of the shortfalls identified would differ in importance. Qualitative analysis is the most effective way to analyze data, and use experience to come up with the best suggestions for design improvements. This thesis is the initial step to quantify, research, study, analyze, and get the conversation started on how to employ the MV-22 so that it can continue to be effectively employed for the next ten years.

CHAPTER 4

ANALYSIS

Introduction

The purpose of this study is to analyze the current organizational make up of a MV-22 squadron in order to determine if a change in size and composition would result in an increased ability to fly aircraft, train personnel, and increase deploy-to-dwell time. Through qualitative analysis of the information collected, the primary and secondary research questions are addressed. The approach applied is designed to determine if there is correlation in performance[24] between the number of aircraft assigned to a squadron, if the squadron is deployed or non-deployed, and if the squadron has been transferring aircraft or keeping aircraft.

When answering the primary and secondary thesis questions, the findings of facts are organized into three main areas. The first area is information that led to the current MV-22 squadron design. The second area is MV-22 squadron performance. The third area is the identification of possible shortfalls within the squadron organization. The secondary questions that must be answered to address the primary question are: (1) why does a MV-22 squadron have twelve aircraft assigned; (2) gave the mission requirements changed from what was originally estimated or planned, and are the current T/O and T/E designed to support the change; (3) has there been a decrease in aircraft MC rates associated with the decrease in dwell-to-deploy time; (4) has there been an increase in

[24] Performance is referring to a squadron's MC rates and flight hour production. In turn, these metrics are indicators of a squadron's ability to conduct maintenance, train aircrew and maintainers, gain and maintain proficiency to support mission requirements.

unit aircraft transfers with decreased dwell-to-deploy time; and (5) has there been a decrease in the trained personnel retention rate with the decreased dwell-to-deploy time?

The first finding of facts section focuses on squadron design and answers the follow-on question: why does a MV-22 squadron have twelve aircraft assigned; and parts of the follow on question: have the mission requirements changed from what was originally estimated or planned, and are the current T/O and T/E designed to support the change? The second finding of facts section focuses on squadron performance and addresses the remainder of the follow-on question: have the mission requirements changed from what was originally estimated or planned, and are the current T/O and T/E designed to support the change? In addition, it answers the follow on questions: has there been a decrease in aircraft MC rates associated with the decrease in dwell-to-deploy time; has there been an increase in unit aircraft transfers with decreased dwell-to-deploy time; and has there been a decrease in the trained personnel retention rate with the decreased dwell-to-deploy time? The final finding of facts section identifies MV-22 squadron design shortfalls that have been discovered throughout the thesis process. Chapter 5 will address solutions to the findings of facts discussed in the three main areas of research.

Findings of Fact

MV-22 Squadron Design

A MV-22 squadron's missions, deployment, manning, parts, equipment, facilities, are all designed around a twelve MV-22 sourced unit. Research for this thesis has found no written evidence as to why twelve aircraft was the number chosen.

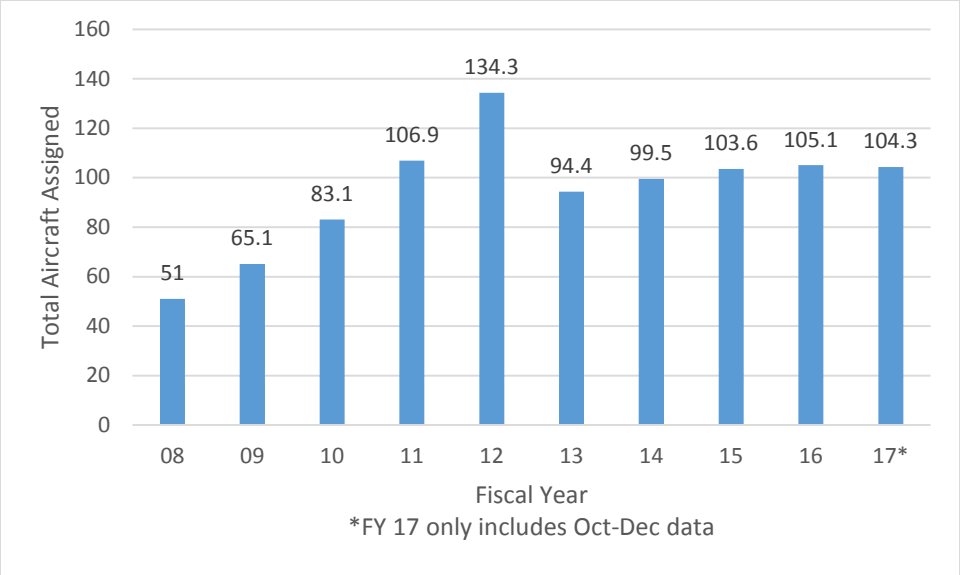

Figure 19. Aircraft Assigned to MAG-26

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

MAG-26 has six operational MV-22 squadrons and one MV-22 training squadron. As illustrated in figure 19, at any given time if the number of MV-22s in MAG-26 is divided by seven, each squadron would never be at twelve MV-22s apiece. The only relevant years of figure 19 are from FY 13 through FY 17. MAG-26 has been fully operational and stabilized since 2013. The years prior to FY 13 are not relevant because squadrons at MAG-26 were still being created, or had swelled to over 100 percent manning and aircraft in order to shift the excess capacity to the west coast for the creation of VMM squadrons there. The average number of aircraft assigned from FY 13 through FY 17 is 101.4. If those aircraft were evenly distributed amongst the seven squadrons at MAG-26, each unit would have 14.5 MV-22s. VMMT-204, the training

squadron, has had its authorized strength and aircraft assigned fluctuate with the varying Headquarters Marine Corps required production numbers for a given FY. The number of aircraft that should be assigned to VMMT-204 is currently fifteen.

At MAG-26, the model manager for MV-22s in the Marine Corps, the only time a unit is allocated with the number of aircraft that matches its manning and equipment design is when it is deployed. With 14.5 aircraft distributed to each squadron and two units regularly deployed if the non-deployed operational squadrons have on average fifteen aircraft, squadrons are required to maintain 25 percent more than they are manned and equipped to handle. How and why is the MV-22 community regularly supporting numbers of aircraft in excess of its designed capability?[25]

Knowing how many aircraft are assigned to squadrons in the fleet, research turned to the programmatic side for information. Discussions, with Headquarters Marine Corps Aviation, former MV-22 commanding officers, and the Marine Corps Historical Society have only resulted in theories. There has been no official USMC document found that states why a MV-22 squadron has twelve aircraft. The requirement is not based on a desired lift capability. It is not based on facilities available. It is not based on space on naval amphibious shipping. The space on amphibious shipping is for the whole ACE. The standard is twelve MV-22s because the mix of aviation assets can remain the same as it was previously with the CH-46. However, MEUs have deployed with only ten MV-22s

[25] When procuring an aircraft purchase for the fleet it is prudent to purchase more than the bare minimum to outfit each unit with twelve aircraft. These excess aircraft are used to replace aircraft when one is destroyed or when they are off at the depot for a several month re-work. However, it still places an increased burden on the units to maintain assets in excess of their designed capability.

or even had CH-53s as the core squadron. The mix of aircraft can be adjusted to Marine Corps desires for that deployment.

The question remained, why does a MV-22 squadron have twelve aircraft? One theme came up in every conversation, MV-22 is a replacement for the CH-46, and the CH-46 had twelve aircraft per squadron. The Marine Corps needed a replacement for its aging medium lift assault support helicopter. Therefore, when it came time to develop the requirements for the next generation of medium lift assault support aircraft, who better to ask than the CH-46 community. A CH-46 squadron had twelve aircraft; it was the core squadron of a MEU. Everything worked, so there is no need to change it.

When it came time to allocate resources, maintenance equipment and manning to a MV-22 squadron, the thinking followed along the same lines. Since the CH-46 did not have a significant amount of avionics, it had a smaller avionics maintenance shop; it was constantly doing airframe work so the airframe shop was larger. Initially, MV-22 squadrons had a large airframes shop and smaller avionics shop. Much of the squadron organization was based on how things had been done previously. Since the MV-22 community has evolved, efforts have been made to tailor shop size to the workload that the MV-22 requires, such as a larger avionics shop due to the aircrafts fly-by-wire technology. Initially MV-22 squadron design was based on CH-46 squadron design. Over time that has begun to change but the legacy construct remains and the MV-22 community is still largely run by former CH-46 pilots. Not until the projected FY 20 lieutenant colonel promotion zone will the first set of pure VMM pilots achieve the rank of O-5 and possible squadron command.

MV-22 Squadron Performance

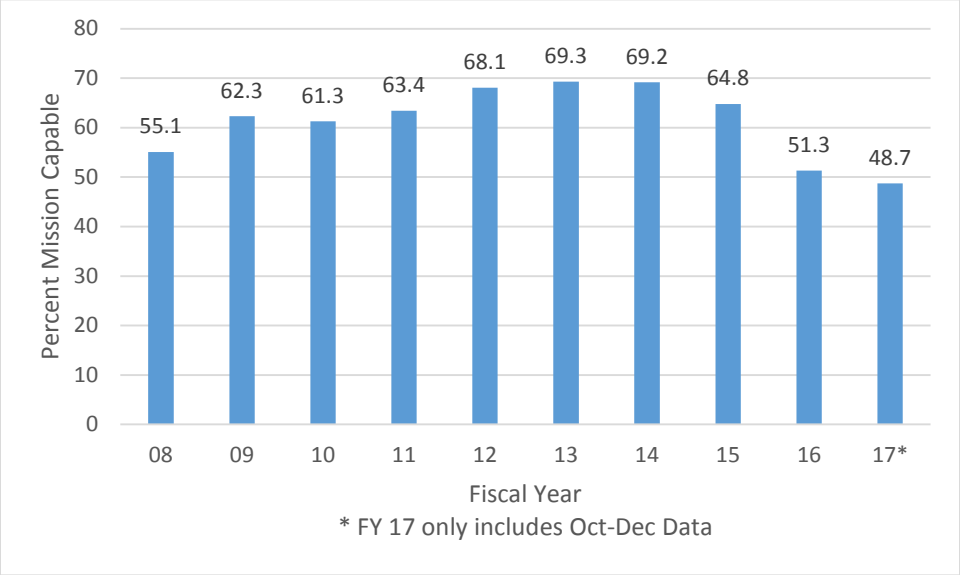

Figure 20. MAG-26 VMM MC Rate by FY

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

MC rate and flight hours flown are generally regarded as the best indicator of squadron performance. Although a squadron's performance is a lot more complicated than those two numbers, they are the easiest to quantify and the most often discussed. In figure 20, the MC rate trend through FY 12 was on a slow but steady increase. In FY 12 through FY 14, the MC rate leveled out. By FY 13 the VMM community had operational squadrons for eight years. One would expect aircrew and maintainer proficiency and expertise to have matured, parts and supply system to be well developed and tested, yet starting in FY 15 the MC rate decreased. In FY 16, it decreased rapidly and in the first

three months of FY 17, it was over 20 percent below what it had been three years previous. There are factors found that have an effect on MC rate.

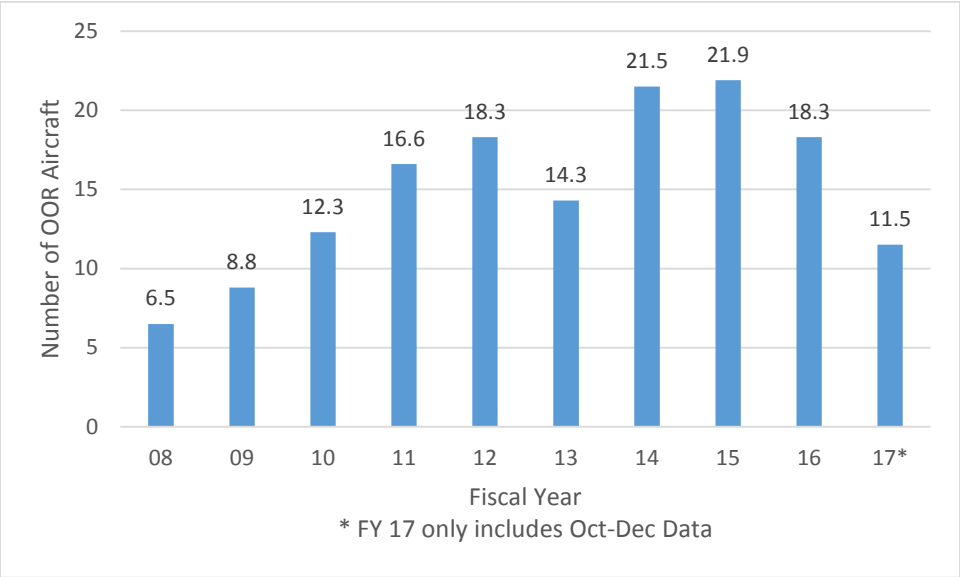

Figure 21. Average Monthly OOR Aircraft

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

One factor affecting the change in MC rate is a change in the requirements for an aircraft to be categorized as OOR. In FY 16 the ability to classify an aircraft as OOR changed from, approval of a depot level repair, to when the repair is actually being conducted. Previously once it was known that an aircraft required depot level repair, that aircraft would be classified as OOR. The changes meant that even if it were known an aircraft needed depot level repair, it would only be classified OOR while the depot level team is on site, conducting the repair. As a result, OOR times often changed from weeks

to days. In figure 21, the number of aircraft classified as OOR shows a significant decrease for FY 16 and FY 17. This causes a direct impact on MC rates because OOR aircraft are not used in MC calculations. For example, if a unit has four aircraft and one aircraft is in need of depot level repair, it is at 75 percent MC rate. If that aircraft waiting for depot level repair were in an OOR status, the MC rate for the unit would be 100 percent. For reporting purposes, if the aircraft is OOR, the squadron is at three of three aircraft, vice three of four aircraft. Placing an aircraft OOR does two things, one good, one bad. First, by not counting the aircraft in the maintenance reports, it prevents a squadron's maintenance department from being penalized for performance it is not approved to conduct. Second, it hides the true status of the squadron's performance capabilities. Two aircraft placed OOR in a squadron with twelve aircraft would increase the MC rate by 16 percent.

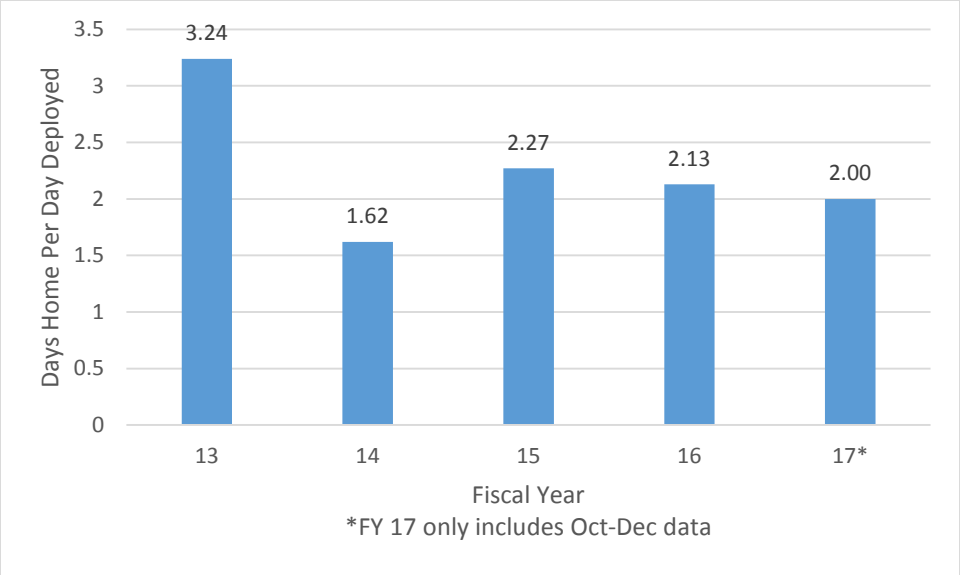

Figure 22. MAG-26 Dwell-to-Deploy Time

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

Other factors affecting MC rate are the rate of deployments for MAG-26. As the time between deployments reduces, the time available to prepare aircraft and personnel for deployments is reduced as well. Increased deployments have meant an increase in aircraft transfers, which will be discussed in the next paragraph. Per Marine Corps Administrative Message 346/14, the minimum ratio for deploy-to-dwell time is two to one. Of the six operational squadrons in MAG-26, the current operational tempo is one squadron deployed on the MEU, one squadron re-constituting from a MEU deployment, one squadron in work-ups for the MEU, one squadron deployed for SPMAGTF-CR-AF, one squadrons re-constituting from a SPMAGTF-CR-AF deployment, and one squadron preparing for SPMAGTF-CR-AF. Squadrons re-constituting after a deployment have a

significant number of personnel rotating out and in. It takes several months to regain the ability to perform normally. During the post-deployment re-constitution, new untrained personnel replace seasoned fully qualified personnel. Not only does it take months to regain the proper complement of squadron personnel, but also the focus of training following the re-constitution is on regaining unit qualifications for the next deployment. The MEU squadron that is conducting work ups is chopped,[26] and operating for the MEU commander, primarily leaving the squadron preparing for SPMAGTF-CR-AF to conduct all MAG tasking. When squadrons re-constitute following deployments, MC rates decrease as untrained personnel replace trained personnel. Tasking from MAG-26 to the squadrons becomes focused on one or two squadrons to fill all of II MEF's aviation support requests. With the demand of II MEF's support requests being sourced to one or two squadrons, initial training for aircrew and maintainers can become secondary. When initial training becomes secondary, it takes longer to train maintainers, aircrew, and results in reduced ability to maintain aircraft and reduced qualified aircrew to support the requests. Figure 22 illustrates that since FY 13, MAG-26 has continuously been operating at or below the minimum deploy-to-dwell time. Four years of minimal deploy-to-dwell time coupled with personnel turnover and aviation support requests allocated to fewer squadrons, has not allowed squadrons to build and maintain experience in aircrew or maintainers. The inability to build and maintain personnel has resulted in a gradual decline in squadron performance.

[26] When a unit is chopped to the MEU, it has been placed in operational control of the MEU commander. The MEU squadron is no longer in the chain of command of the MAG commander, and now works for the MEU commander. A squadron is chopped to the MEU six months prior to deployment.

With increased deployments, there are increased aircraft transfers. Due to different configurations of the aircraft, certain aircraft are required or preferred to go on certain deployments. For example, every aircraft that goes on a MEU must have the fire suppression system installed in the sponsons of the aircraft. Not every aircraft has the modification. There are also aircraft blocks, which correspond to when they were built and there configuration, think of it as the difference between Nissans 270Z, 300Z, and 350Z production lines. They are all from the same line of car but have different upgrades and capabilities that improved with time. Block C aircraft have weather radar, some avionics upgrades and some are updated with the mission computer obsolescence initiative. There are old block B aircraft and new block B aircraft that have different components. There is additionally block A to B, which is aircraft that have undergone modification from block A configuration to block B configuration. Finally, there are also block A aircraft. No block A aircraft has ever gone on deployment, and block A aircraft had been consolidated to VMMT-204, because it is the non-deployable training squadron. In 2017, VMMT-204 transferred its entire block A aircraft to operational squadrons and received all block C aircraft. This is an attempt to reduce the maintenance man-hours for VMMT-204 in order to keep up with its aircrew production requirements. Block A aircraft are the most maintenance intensive aircraft due to age, wear, and configuration. In the first three months of 2017, there have been fifty transfers of aircraft between units in MAG-26. In 2016, there was over seventy aircraft transfers. Transfer data can be found in appendix A.

With each aircraft transfer there is an initial dip in MC rates and continual transfers show implications for long-term decreases in MC rates. To conduct an aircraft

transfer, two squadrons conduct a joint itemized inspection of components installed on the aircraft, and verify all administrative paperwork matches the itemized inspection. Additionally, in the joint review of the administrative records, all modifications, engineer improvements, inspections, and maintenance performed on the aircraft is verified correct and up to date. Through the in-depth joint inspection, discrepancies are noted and remedied. Following the joint inspection, the accepting squadron conducts a functional check flight to ensure the aircraft is fully operational. Depending on the process and what is found, an aircraft transfer can take a day, to over a week. Throughout the aircraft transfer process the aircraft is not available to be used for training or missions. Squadrons taking part in the SPMAGTF-CR-AF have been transferring all twelve of their aircraft prior to deployment and accepting twelve new aircraft once arriving in Spain. The unit returning from Spain accepts the aircraft that the unit that replaced them left behind. In incidents like this, there is often insufficient time or personnel available to conduct in-depth joint inspections. Over time, with the significant number of aircraft transfers MAG-26 has been conducting, the material readiness of aircraft has decreased. Due to qualification requirements to be prepared for deployment and limited time to train prior to deployments, squadrons must fly the aircraft that are MC, when they are MC. That means that long-term maintenance planning and grooming of aircraft is not able to be conducted. Maintaining a good glideslope on the "Phase Tree" becomes secondary to gaining qualifications needed for the upcoming deployment.[27] A lack of phased planned

[27] Phase maintenance is planned maintenance done at a prescribed flight hour. Like changing your oil every 5,000 miles, every 210 hours flown the aircraft needs in-depth maintenance tasks performed. There are four different types of phases; all have varying degrees of invasiveness. A and C phases require less maintenance actions, while

maintenance, results in maintenance departments being reactionary, and unable to support daily operational requirements. Additionally, since maintenance becomes Band-Aid fixes to meet the daily flight schedule, the quality of the aircraft drops over time resulting in a decrease in MC rate. With the constant rotation of aircraft, any sense of long-term ownership is lost and any incentive for pride in squadron aircraft is taken away.

B and D phases are more in–depth. Phases go in order and once an aircraft has conducted a complete cycle of phases after 840 hours, following the next 210 hours of flight time, it conducts an A phase and the cycle starts over. A phase tree is a graphical depiction of all the aircraft and the hours they have until a phase is required. On the left would be the aircraft that just completed a phase inspection and has 210 hours left to fly until it needs another phase. Ideally, the chart shows a steady and linear decrease as it goes to the right until the last aircraft on the right is at or near zero meaning it is time to conduct phase maintenance on that aircraft. Phase inspections can take weeks so you only want one aircraft in phase at a time to allow the maximum aircraft for flying. This is managed by allocating certain aircraft to fly certain flights so that the hours are flown in a way that is advantageous for the maintenance department to meet the squadrons' operational goals. If you must always fly what is available the tree will not be a steady glideslope but stair steps with multiple aircraft requiring phase at the same time.

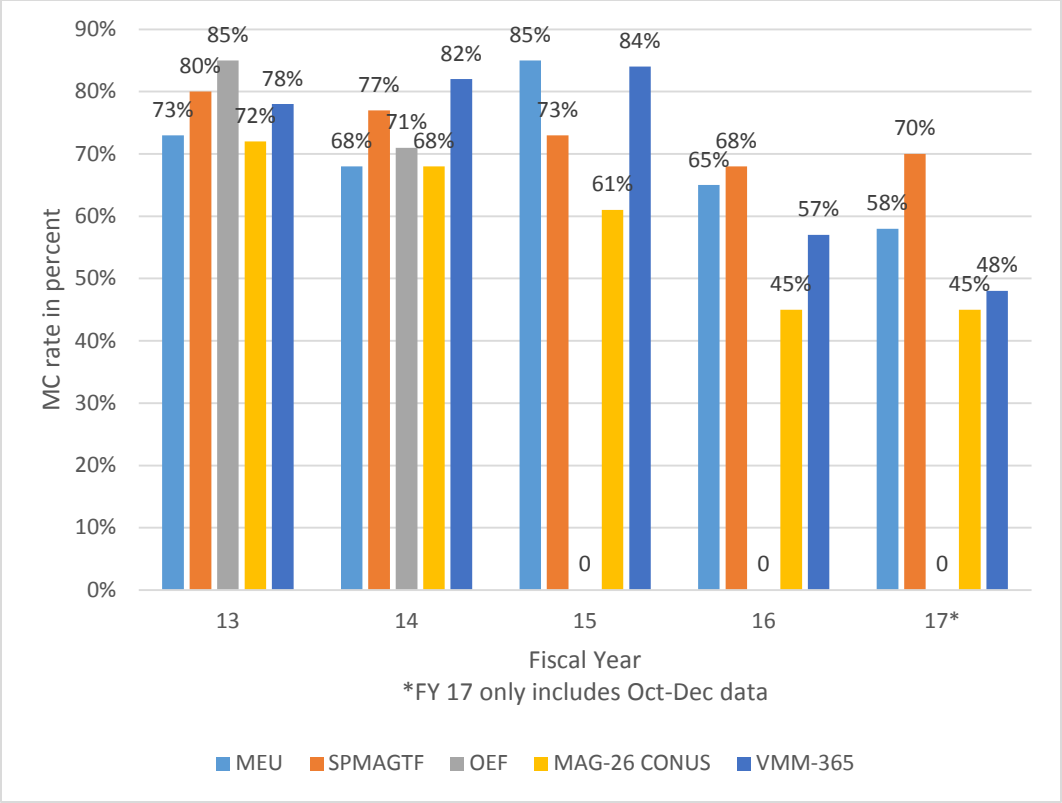

Figure 23. MC Rate by Location

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

MC rate is also affected by location or deployment status. Figure 23 depicts that MAG-26 CONUS squadrons have had the lowest MC rates. Because there is more space and facilities available, land based deployed squadrons traditionally have higher MC rates than MEU squadrons. Deployed squadrons should always have higher MC rates than CONUS based MAG-26 squadrons; because, they have a higher parts priority or F/AD status, in addition to a fully trained compliment of maintainers and only twelve aircraft. Across the board, the MC rate has seen a slow but steady decline no matter the

squadron's status. VMM-365 is broken out to illustrate a possible outcome of limiting aircraft transfers. In FY 13 its SPMAGTF rotation was only a six aircraft detachment so the squadron was able to have a reduced amount of aircraft transfers. In the years following, it conducted a MEU, followed by another rotation on the MEU. Since MEU squadrons retain their aircraft unlike SPMAGTF squadrons, the number of transfers VMM-365 conducted was less than other squadrons in MAG-26. One result was the long term grooming and ownership of aircraft. Since FY 13 VMM-365 has always had a higher MC rate than the rest of MAG-26. There may be many reasons for this, leadership, luck, maintainer expertise, etc. Since those reasons are all human centric, with the high turnover rate of squadrons, it is unlikely they are the reason behind maintaining a higher MC rate over a multi-year period. The one statistical difference for VMM-365's performance is the reduced number of aircraft transfers they conducted.

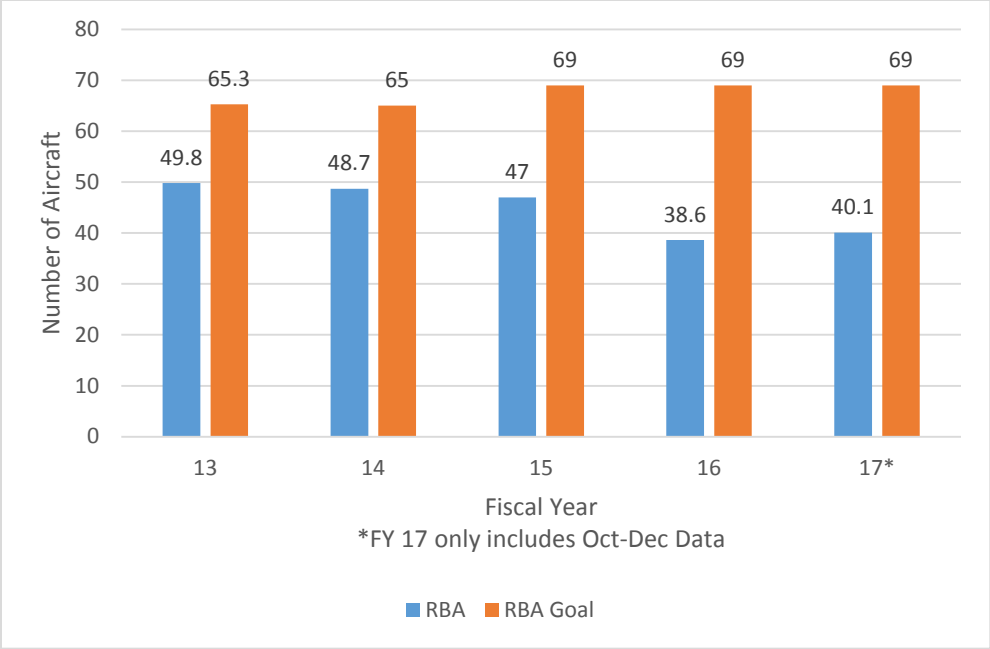

Figure 24. RBA versus RBA Goal

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

RBA is the number of aircraft that are ready for training or mission flights. As illustrated in figure 24 since FY 13 there has been an overall steady decrease with an initial uptick for the beginning of FY 17. A reduced number of RBA aircraft correlates to what was described in the paragraph above in regards to the management of the phase tree. With fewer aircraft available to fly, squadrons are forced to fly the aircraft that are up, when they are available. Maintenance departments cannot groom or massage the phase tree. The number of hours it takes to train aircrew to achieve the qualifications has not changed, therefore with less RBA aircraft; more hours are being flown on fewer aircraft.

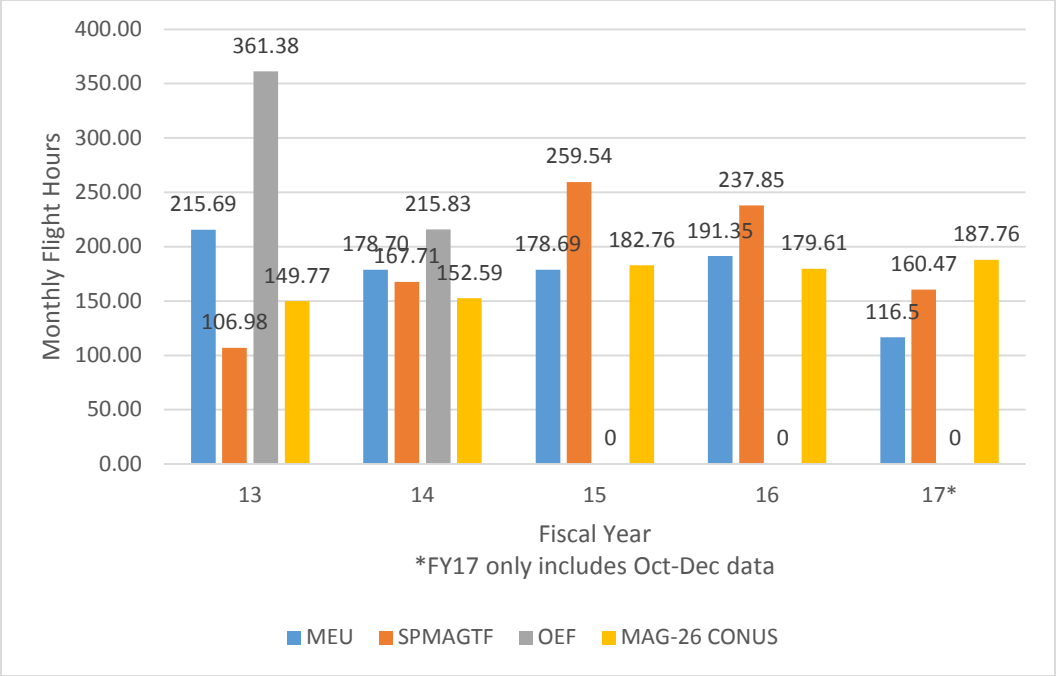

Figure 25. Average MC Rate for Non-deployed versus Deployed Squadrons

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

Monthly flight hours vary greatly depending on location, mission, holidays, and weather. Land based deployments such as OIF and OEF traditionally resulted in a significant increase in monthly flight hours for the aircrew. The SPMAGTF-CR-AF and the FY 14 OEF missions changed the status quo. During OIF and OEF squadrons were conducting general support, conducting daily battlefield circulations of parts, equipment, mail, personnel and V.I.P.'s, along with conducting missions. In FY 14, the OEF squadron mission changed from general support to casualty evacuation standby. The only flight hours were daily weapons checks and transit to detachment sites to decrease the response time for casualty evacuation of certain missions. At the same time, the

SPMAGTF-CR-AF, also a land based deployment, increased to a twelve aircraft requirement in FY 14 and only exists for stand by operations in United States Africa Command. Depending on the time of year, and joint exercises that are conducted, the squadron has trouble maintaining the required proficiency for its aircrew. MEU's vary greatly in the number of hours flown depending on if they conduct pre-planned North Atlantic Treaty Organization exercises, or if they receive national tasking, such as supporting a natural disaster. Collectively, deployed squadrons are experiencing on average less flight hours than they had prior to FY 14.

Since OEF ended in FY 14, MAG-26 began to only support two deployed units at a time. Beginning in FY 15, monthly flight hours stabilized at 179 to 187. In order to maintain pilot proficiency and safety in the aircraft, II MAW's policy is that each pilot must fly a minimum of fifteen hours per month. Since a VMM squadron has twenty-eight pilots, and two pilots fly at a time, a minimum of 210 monthly flight-hours are required for each pilot to reach the minimum of fifteen flight-hours. If a squadron could perfectly distribute the flight hours, 210 hours would be all that is needed; however, MAG-26 squadrons are preparing for deployment. Certain pilots are working through pre-requisite flights and qualifying flights and need more than fifteen hours per month to be qualified to deploy. Additionally, only certain instructors have the qualifications to teach initial flights, and as a result end up flying the preponderance of flights. When training, a squadron needs in excess of 210 flight hours to train the new pilots, while maintaining the current pilot proficiency concomitantly. Figure 25 shows that MAG-26 squadrons have been unable to meet an average of 210 flight hours per month. In order to make up for this, squadrons have had to rely on the simulator in order to acquire fifteen hours of flight

time per month. Pilots are facing decreasing opportunities to gain proficiency and qualifications with the reduced flight time both on deployment and in training.

Since no two deployments are the same length, or conduct the same missions. Individual deploy-to-dwell time varies. The best representation or baseline of a MV-22 squadron's readiness capability is the non-deployable training squadron. Figures 26, 27, 28, and 29 show the specific data for training squadron VMMT-204.

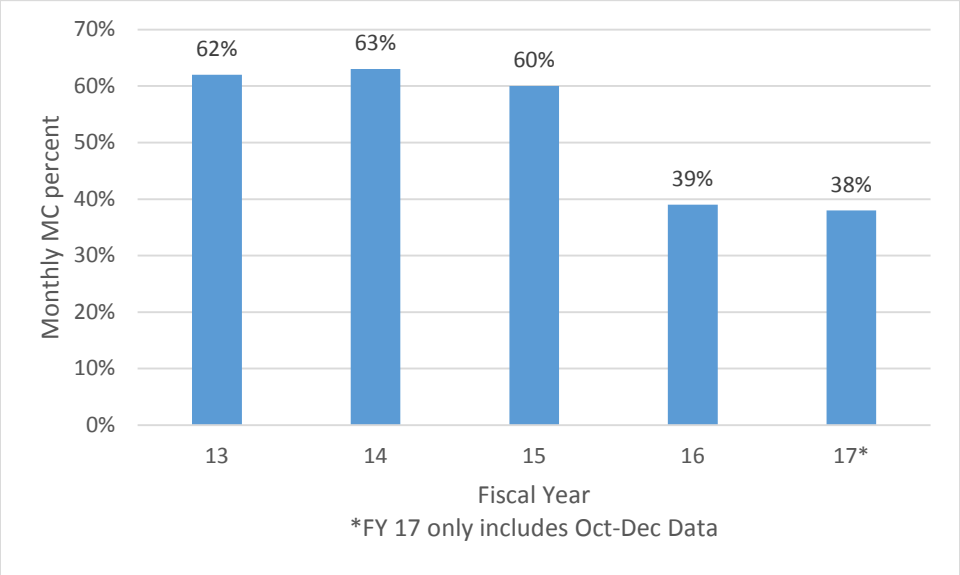

Figure 26. VMMT-204 Average Monthly MC Rate

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

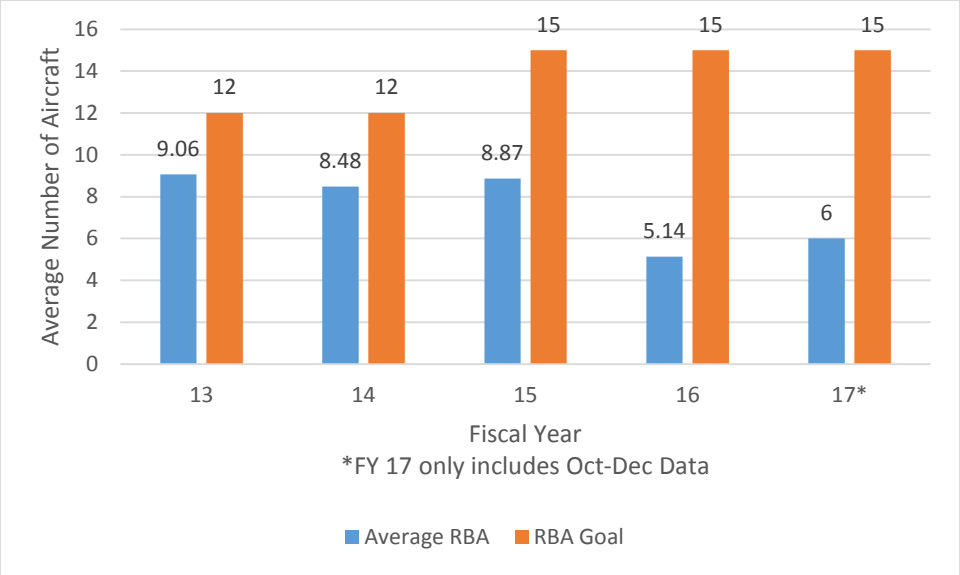

Figure 27. VMMT-204 Average RBA versus RBA Goal

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

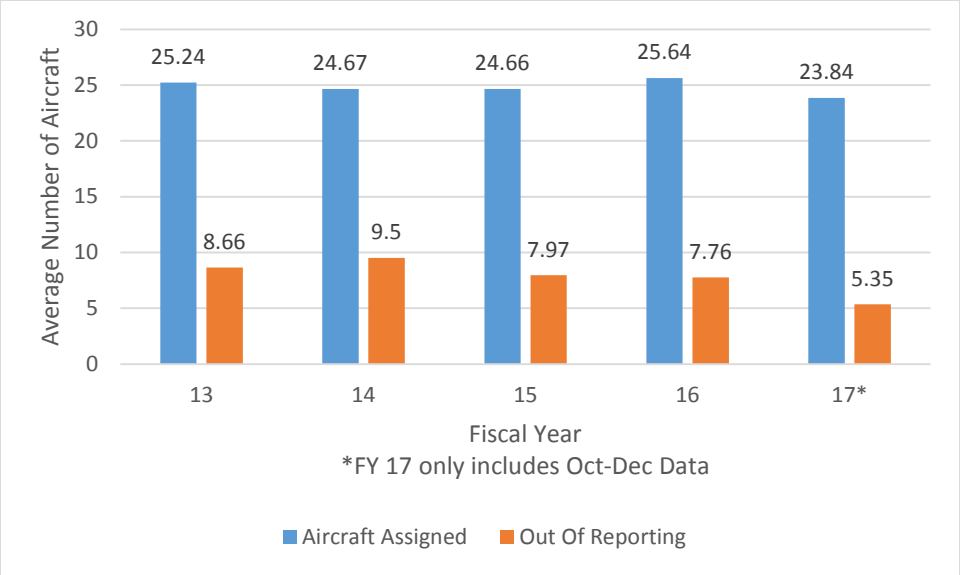

Figure 28. VMMT-204 Average Aircraft Assigned versus OOR Aircraft

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

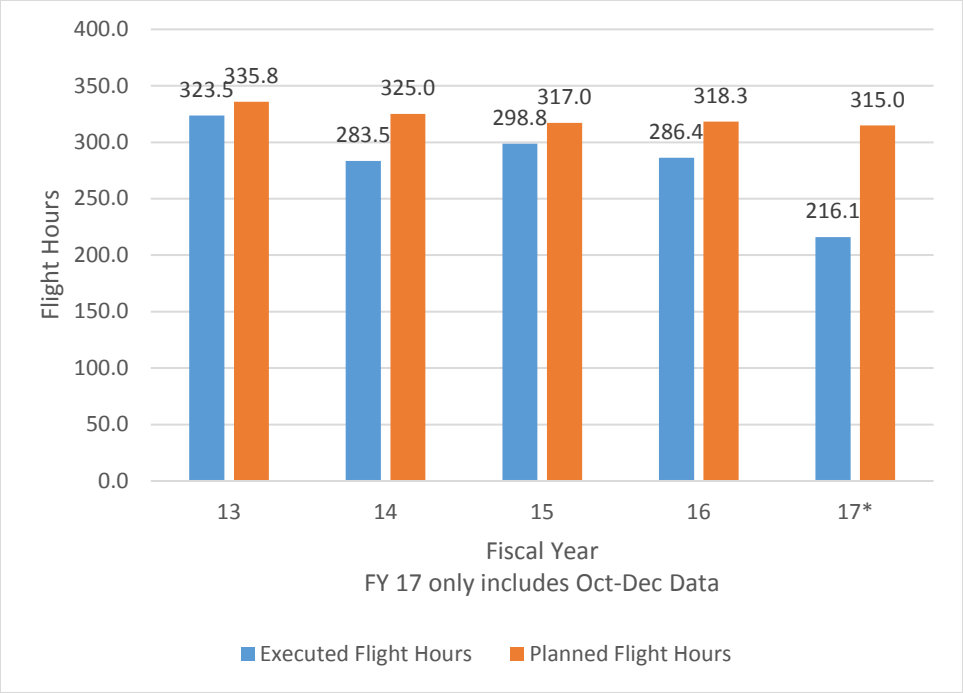

Figure 29. VMMT-204 Average Executed versus Planned Flight Hours

Source: Created by author using data from "MV-22 Monthly Data Spreadsheet," provided by Robert Clinton, V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC, in e-mail correspondence with author, December 2016-April 2017.

VMMT-204 paints the same picture that is echoed in the rest of MAG-26. The MC rate has been declining. The number of aircraft assigned far exceeds its manning and equipment to maintain them.[28] VMMT-204 is experiencing a reduced MC rate, it is able to produce fewer RBA, and the gap between planned flight hours and executed flight hours continues to increase. Just like the rest of MAG-26, VMMT-204 has had a decrease in OOR aircraft, however the reduction is primarily due to the change in reporting status

[28] VMMT-204 regularly has multiple aircraft at Cherry Point undergoing depot level periodic maintenance inspections. Therefore, they do not physically have all aircraft assigned to them on their flight line. However, they are usually in excess of eighteen aircraft to maintain.

rather than an improvement in aircraft support or maintenance practices. Whether a squadron is operational or a training, shortfalls are consistent throughout the MAG.

MV-22 Squadron Design Shortfalls

Overall, the ability of squadrons to maintain and fly MV-22s has decreased since FY 13. The facts described previously in this chapter outline several shortfalls.

Squadrons are not manned properly to maintain the number of aircraft for which they are responsible. When not deployed, squadrons regularly have in excess of 25 percent more aircraft than they are designed to maintain. As a result of the excess workload, squadrons are only able to maintain aircraft in a state that is good enough for them to fly. There are only enough man-hours available to make aircraft PMC instead of FMC. PMC is an aircraft reporting status that equates to some non-essential systems being non-operational. A car that has a bad compressor and therefore no air conditioning would be PMC. FMC means that every system on the aircraft is operational. The FMC rate for CONUS based MAG-26 squadrons is regularly below 10 percent.[29] With excess aircraft, squadrons do not have enough manpower to devote time to fixing everything that is broken.

Operating at or near the minimal deploy-to-dwell time for several years has resulted in a reduction in capacity to produce qualified maintainers between deployments. As a result of the decreased capacity to produce qualified personnel, there has been an increase in the number of times qualified maintainers are deploying. Statistically it is difficult to correlate a direct relationship between the MV-22's increased deployment

[29] FMC data is in Appendix A.

cycle with a retention decrease of qualified maintainers, since qualifications are not tracked as part of the out-process data. However, what can be proved statistically is the increase in demand for and contracting of civilian contractors. Since 2013, the contract maintenance footprint at MAG-26 has increased by over 200 percent. VMMT-204 now has over thirty full-time contract maintainers. MALS has over thirty full-time contractors that they temporarily assign to individual squadrons to assist with normal maintenance. As the units communicated that they did not have enough qualified maintainers to keep up with the demand, approval was given to increase contract support. Since there is no civilian base of maintenance expertise or experience, the V-22 contract maintainers came from the MV-22 community and are previous USMC maintainers. The MV-22 has demanded more of its maintainers to meet the operational requirement and at the same time given them incentive to not re-enlist and become a contract maintainer. It is not only better initial pay, but there are no deployments, the physical standards are lax, and there is no annual Marine training. It is reasonable to say that the increased operational tempo has had a negative effect on the retention rate of qualified maintainers given the option to become contractors.

Another shortfall is tools and equipment. Just like personnel, squadrons are attempting to maintain fifteen plus aircraft with the tools and equipment present to fix only twelve, or maintain eighteen plus aircraft with tools and equipment to maintain fifteen in VMMT-204's case. For example, a common practice is to borrow from adjacent units to have enough jacks or stands to conduct daily maintenance.

The legacy construct of manning and equipment has begun to effect the ability of squadrons to meet obligations while deployed or they are forced to accept increased risk.

VMMs like HMMs were designed to deploy as entire entities. HMLAs and HMHs send detachments to join up with the core squadron, a VMM, to form an ACE. The core HMH or HMLA squadron has the depth of personnel and equipment in each maintenance shop to not limit capabilities at either the detachment or core squadron. VMMs only have personnel depth, specifically in maintenance leadership positions, for one location on 24-hour operations. Increasingly, VMMs are being tasked to conduct simultaneous, multiple site operations while on deployments. In particular, the SPMAGTF-CR-AF advertised the ability to conduct simultaneous operations in two locations while leaving a limited number of personnel at home base conducting planned maintenance. In order to operate at three different locations, the ACE commanding officer was forced to accept significant risk in the ability to maintain these distributed operations for any time longer than a few days. The ordinance shop, for example, does not have the depth of personnel to be able to conduct more than two shifts. Dual site operations require four shifts of personnel. The ACE commanding officer would accept risk by placing one shift of personnel at each location on a 24-hour standby. Aviation life support systems are the same way. They have one Quality Assurance Safety Observer if he is needed in a location he is not at; the maintenance action will have to wait until he can get there. For flight line, since half of the workers are also aircrew, in multi-site operations where aircrew are involved in flying, bodies available to maintain the aircraft become insufficient.

Conclusions

The data shows that since FY 13 there is a decrease in performance for MV-22 squadrons in MAG-26. If the current trajectory continues, squadrons will be unable to meet the USMC's deployment obligations. Three years ago, the Commandant of the

Marine Corps stated that the Marine Corps is in such demand and had so many obligations that it was no longer only using its feed corn, it was also consuming its seed corn. He went on to say that if steps are not put in place, the Marine Corps will use up its resources now and not have any seed to grow the force of tomorrow.

MAG-26 is at a cross roads, it is not producing enough aircraft or flight time to train maintainers and pilots at the rate it needs them. It is making ends meet by placing a greater burden on individuals who have already been trained. MAG-26 is past the feed corn and into the seed corn. With the significant turnover of personnel in the Marine Corps, once the feed corn starts disappearing, it is nearly impossible to build that up again. Chapter 5 discusses avenues to help stop the consumption of the MV-22 experience seed corn and build a sustainable model for the MV-22 squadron.

CHAPTER 5

INTERPRETATION OF FINDINGS AND RECOMMENDATIONS

The purpose of this study is to analyze the current organizational make up of a MV-22 Squadron in order to determine if a change in size and composition would result in an increased ability to fly aircraft, train personnel, and increase deploy-to-dwell time. Using the facts laid out in chapter four, this chapter interprets the information and provides recommendations for MAG-26 MV-22 squadrons.

Interpretation of Findings

The current rate of employment and squadron design are insufficient to maintain MV-22 squadrons. If maintenance trends remain consistent, VMMT-204 will be unable to meet its mission starting this year. MAG-26 operational units are on trajectory to be unable to produce enough training and proficiency flight-hours for its aircrew to meet the current operational obligations. Due to the decrease in ability to train personnel, MAG-26 will need to transfer qualified personnel to squadrons deploying or commanders will be required to accept additional risk in the squadron's ability to safely conduct missions.

Chapter 4 shows that there has been a constant decline in the ability to maintain aircraft since FY 13. With each passing year, the ability to train aircrew and maintainers decreases. As experienced personnel move on to subsequent tours of duty or depart the service, the next generation of personnel must replace them. Continual high operational tempo, personnel turnover, and decreased training opportunities have resulted in subsequent generations of aircrew and maintainers having less experience than the previous generation. The pool of knowledge is slowly dwindling in the MV-22

community and is not being passed on to the next generation. The demand for MV-22 support in both training and combat is exceeding the communities' ability to keep up. The MV-22 community is out of feed corn and running on seed corn to make mission.

Chapter 4 described shortfalls in squadron design and support. Most of the shortfalls can be traced to treating the MV-22 like the CH-46 it replaced. Assumptions about maintenance manning, time to build maintainer expertise, supply availability, and aircraft repair came primarily from the CH-46 community. The Marine Corps had a firm handle on the CH-46 community, its capabilities, its maintenance, and its upkeep. Through the research for this thesis, some assumptions were made that the MV-22 community would be just like the CH-46 but with more range, speed, and payload. However, aside from its cabin size, the MV-22 is a completely different aircraft with completely different requirements for support and capabilities.

Recommendations

There are two recommendations that would have significant effects on the MV-22 community. One recommendation is a change in the design of the MV-22 squadron. This change in squadron design would affect the number of aircraft, personnel, and equipment assigned to a squadron. As a result, the change in design would have significant effects on the ability to maintain aircraft, fly aircraft, train personnel, individual deploy-to-dwell time, and even retention. The other recommendation is to stop aircraft transfers amongst squadrons.

Changes in squadron design will have an immediate and long-term positive effect on the MV-22 community. The research has shown that the only reason MV-22 squadrons have twelve aircraft is because CH-46s had twelve aircraft per squadron. Since

the twelve aircraft construct is only held to for deployment, the number of aircraft per squadron is somewhat arbitrary; therefore, a change in aircraft assigned should not be out of the question. Whatever the number of aircraft is, there needs to be a corresponding number of maintainers and equipment to support it. By only having enough parts and maintainers to maintain the number of aircraft assigned while executing deployment, non-deployed units are at an extreme disadvantage. A squadron design solution that would improve maintainability and supportability would be to make the MV-22 squadron have eighteen MV-22s, and correspondingly 150 percent of its current manning.

By taking three squadrons, cutting one in half, and giving half to two other squadrons, you would have two squadrons of eighteen MV-22s and 150 percent the current manning. From an organizational/design standpoint, no increase in manning or facilities are required. Therefore, no change in the number or size of squadron spaces or hangers would be needed. Deployments could remain sourced at twelve MV-22s, so no change in the requirements on a ship or overseas would change. Having eighteen aircraft and deploying twelve now allows the MV-22 squadron to retain a rear-detachment, while currently that ability does not exist. A MV-22 squadron deploys in its entirety and anyone or any aircraft that cannot deploy is transferred to another squadron or MAG-26.

A rear-detachment would benefit the MV-22 community greatly. As stated earlier currently any personnel or aircraft not suited for deployment is transferred to another unit or the MAG. Continuity is extremely important when it comes to personnel or aircraft. With the high operational tempo of MV-22 squadrons, non-deployable personnel are often transferred from the unit deploying to the unit that is returning. Squadron leadership does not have the opportunity to get the whole story or ensure continuity for individual

Marines. Mistakes in paperwork for administrative separations, medical review boards, enlistments, schools, can and often do happen as the personnel are swapped out in conjunction with a deployment or return from deployment. The rear-detachment allows continuity and oversight. The rear-detachment also allows a squadron to continue to train its personnel and repair aircraft. If required the squadron now has personnel and aircraft it can source for replacements of deployed personnel and aircraft should the need arise.

Another effect of increasing the squadron size is the ability to stabilize and further refine maintainer qualifications. With fewer squadrons, there should be correspondingly fewer movements of maintainers. Fewer moves and increased depth of maintainers would increase the efficiency of the maintenance department. There is currently more work to be conducted than there are man-hours available for the MV-22. One example of the overload in work is the regularly low FMC rate at around 10 percent or lower for the last two years. There are only enough man-hours available to make aircraft PMC not FMC. The only way to improve the ratio of workload to man-hours available would be to increase manning or increase the efficiency of the manning on hand. With size limitations of the Marine Corps, an increase in MV-22 manning would mean a decrease in manning somewhere else in the Corps, not likely. Therefore, a squadron must do more with what it has. The consolidation of three squadrons to two would increase the density and depth of expertise within each squadron. With additional aircraft, there would also be additional workload; however, with the increased density and depth of expertise, an individual job will be conducted faster and more can be accomplished in the same amount of time. With the increased stabilization of maintainers, more attention could be dedicated to

proficiency and increasing qualifications of the individual, thus creating better instructors for the next generation of maintainers.

An increase in squadron personnel along with an increased pool of qualified Marines allows the unit commander to more effectively control who deploys and how often they deploy. There are only two ways to improve deploy-to-dwell time. One is to conduct fewer deployments. The other is to increase the number of personnel available to deploy. Since the suggestion neither reduces the service's obligations nor creates new manpower, the overall deploy-to-dwell ratio within the MAG would remain the same. However, with a larger squadron size and a rear-detachment, the squadron commander has control over who deploys within his unit. Squadron leadership can decrease or increase the deploy-to-dwell ratio on the individual Marine by selectively choosing whom they are taking for deployments. With the increase in depth of personnel, not every member of the command would need to deploy. The commander would have the leeway to give individuals a break from deployments and continue to deploy others who desire to deploy.

Increasing the size of the squadron and having a rear-detachment allows for fewer transferring of aircraft. From discussions with commanding officers, maintenance officers, maintenance chiefs, and maintenance material control officers, the single most degrading factor effecting squadron performance is the large numbers of aircraft transfers. Increasing the squadron size to eighteen aircraft allows for the flexibility of retaining aircraft within the squadron that are unfit or un-preferred for deployment. Squadrons should retain their aircraft if possible. There are many reasons that aircraft are

being transferred within MAG-26. Currently the SPMAGTFs are driving a significant portion of transfers in the MV-22 community.

The MV-22 is trans-oceanic capable and this performance capability is being under-utilized. Squadrons should keep the aircraft they have flown and maintained leading up to the deployment on the deployment as well. Ownership, familiarity, planned phase maintenance timing, and aircraft pride, would all be preserved. The process of transferring aircraft for land-based deployments like SPMAGTF and formerly OIF and OEF is treating the MV-22 just as the CH-46 it replaced.

In addition to the SPMAGTF driving aircraft transfers, transfers will still occur until a standard squadron composition of aircraft is agreed upon and aircraft configurations are uniform to all aircraft. The aircraft composition being referred to is the mix of block B and block C aircraft. The mix of aircraft has constantly changed, depending on maintenance cycle, deployment type, and squadron commander. It matters less what the mix is, than if it is standardized. Along with the composition of aircraft, configurations of aircraft drive transfers for deployments.

Aircraft configuration must be universal. Aircraft receive modifications for a number of reasons. Aircraft modifications may be because parts manufacturers have changed and components no longer behave the same way. Such was the case with the nose landing gear strut, and an associated engineering change to accommodate. Some modifications are conducted to improve current design, such as engineering change proposals, for example a more robust bearing design within the aircraft nacelles. Other modifications are conducted because the Marine Corps wants additional capabilities; such as forward firing chaff and flares for defeating anti-aircraft munitions. Sponson fire

suppression systems, laser counter measures, mission computer obsolescence incentive, are all other modifications being conducted, and with each modification, the aircraft has a different configuration. Due to constraints, the modifications are not being completed on every aircraft. Lack of modifications results in some aircraft being ill-suited or prohibited for certain deployments. Time, funding, manpower, and civilian manufacturing capacity are all constraints that are prohibiting modifications from being implemented across the fleet.

Funding is the biggest constraint for universal configurations of the aircraft. The desire for the next capability tends to override the ability to monetarily support the previous initiatives. There must be a common configuration of the aircraft, or transfers will never stop. An increase in aircraft per squadron will improve the reduction of transfers for configuration reasons, but it is a disservice to only outfit some of the fleet and then move on to the next aircraft modification.

Summary and Conclusions

The MV-22 is a leap forward in capabilities and relevancy for the Marine Corps. It is in such high demand that it has attracted buyers from Japan, the Air Force, and the Navy. Every demand signal in the MV-22 community is increasing, more demands for parts, more demand for support equipment, more demand for engineering support, and more demand for experienced aircrew and maintainers. The ability to support the demand has been unable to keep pace, as is evident in the MC rates of MAG-26. Something has to change or units will be unable to safely continue executing operational requirements.

The MV-22 is not a legacy platform and legacy thinking needs to change. Many of the MV-22 organizational decisions were based on how the CH-46, a legacy platform,

operated. It is not that the Marine Corps was not planning; they just did not know what they were planning for at the time. The Marine Corps did the best they could to try and apply legacy thinking to the new platform. However, the construct has flaws that are beginning to show.

For example, an expert avionics man takes at least four to five years to develop in the MV-22 community. The time Marines are about to become experts in their field, it is either time they transition to civilian life or to conduct a "B"[30] billet. As technology advances and platforms become more complicated, like the MV-22, time and turnover of personnel become the enemy. Technology has changed, and as a result has come head to head with some traditional Marine Corps practices.

The CH-46 was the core of the ACE. The idea that twelve medium assault aircraft shall be that core has become engrained in the Marine Corps culture. Changing the construct and design of the VMM does not mean that the ACE core has to change. Everything and everyway the Marine Corps operated while deployed can remain the same with an eighteen aircraft VMM design. However, by changing the VMM squadron design and allowing it to have a rear-detachment would allow much more utility and flexibility. There are drawbacks to a larger squadron size. By reducing the number of squadrons to make individual squadrons larger, the Marine Corps has lost structure. There would be fewer VMM squadrons. This larger squadron construct is for MAG-26 and its possible benefits exceed its possible detractions. Okinawa, the reserve squadrons,

[30] A B billet is an assignment outside of the primary occupational specialty for a Marine. For a MV-22 maintainer it would be a tour such as embassy duty, recruiting, drill sergeant, school instructor etc. It exposes the Marine to the other missions of the Marine Corps, but prevents him from further education in his primary job specialty until the completion of the tour.

and even the West coast squadrons have somewhat different challenges and different allocations of block C and B aircraft, combining three squadrons to make two is not an across the board solution.

The Marine Corps threw away the mold and took a chance when it procured the MV-22. It is time it threw away the mold on design and support of MV-22 squadrons as well.

APPENDIX A

AIRCRAFT TRANSFER ORDERS

Number of Transfers	ATO	TMS	BUNO	CUST	RECMD	TXT/NLT
1	H343-13	MV-22B	168291	CNAF	VMM-162	30-Jun-13
2	H402-13	MV-22B	168293	CNAF	VMM-162	31-Jul-13
3	H440-13	MV-22B	168294	CNAF	VMM-162	30-Aug-13
4	H441-13	MV-22B	168295	CNAF	VMM-261	30-Aug-13
5	H469-13	MV-22B	166721	VMM-365	VMM-162	30-Sep-13
6	H470-13	MV-22B	168225	VMM-365	VMM-162	30-Sep-13
7	H480-13	MV-22B	168296	CNAF	VMM-261	30-Sep-13
8	H481-13	MV-22B	168298	CNAF	VMM-365	30-Sep-13
9	H4106-13	MV-22B	168299	CNAF	VMM-365	30-Oct-13
10	H4107-13	MV-22B	168300	CNAF	VMM-264	30-Oct-13
11	H153-14	MV-22B	168303	CNAF	VMM-264	30-Nov-13
12	H154-14	MV-22B	166499	VMM-365	VMM-263	30-Nov-13
13	H155-14	MV-22B	166742	VMM-263	VMM-365	31-Dec-13
14	H178-14	MV-22B	168323	CNAF	VMM-264	31-Dec-13
CY14						
1	H292-14	MV-22B	168325	CNAF	VMM-365	31-Jan-14
2	H293-14	MV-22B	168326	CNAF	VMM-266	31-Jan-14
3	H294-14	MV-22B	168333	CNAF	VMM-264	31-Jan-14
4	H382-14	MV-22B	168340	CNAF	VMM-266	20-Jul-14
5	H434-14	MV-22B	168346	CNAF	VMM-365	30-Sep-14

6	H446-14	MV-22B	168347	CNAF	VMM-162	30-Sep-14
7	H480-14	MV-22B	168349	CNAF	VMM-261	30-Nov-14
8	H482-14	MV-22B	168351	CNAF	VMM-261	30-Nov-14
9	H483-14	MV-22B	168352	CNAF	VMM-166	30-Nov-14
10	H127-15	MV-22B	168601	CNAF	VMM-162	31-Dec-14
11	H128-15	MV-22B	168602	CNAF	VMM-162	31-Dec-14
CY15						
1	H185-15	MV-22B	168605	CNAF	VMM-264	31-Mar-15
2	H212-15	MV-22B	168607	CNAF	VMM-264	30-Apr-15
3	H220-15	MV-22B	168609	CNAF	VMM-264	30-Apr-15
4	H302-15	MV-22B	168611	CNAF	VMM-263	31-Jul-15
5	H407-15	MV-22B	168615	CNAF	VMM-365	31-Aug-15
6	H101-16	MV-22B	168618	CNAF	VMM-365	30-Nov-15
CY16						
1	H164-16	MV-22B	168622	CNAF	VMM-266	31-Jan-16
2	H245-16	MV-22B	168630	CNAF	VMM-261	31-May-16
3	H268-16	MV-22B	166691	VMM-261	VMMT-204	30-Jun-16
4	H269-16	MV-22B	166490	VMMT-204	VMM-263	30-Sep-16
5	H309-16	MV-22B	168238	VMM-261	VMM-365	31-May-16
6	H310-16	MV-22B	168351	VMM-266	VMM-261	31-May-16
7	H312-16	MV-22B	168618	VMM-365	VMM-261	31-May-16
8	H332-16	MV-22B	167918	VMM-365	VMM-774	31-May-16
9	H344-16	MV-22B	168349	VMM-266	VMM-261	15-Jun-16
10	H345-16	MV-22B	165843	VMM-266	VMM-162	15-Jun-16

11	H346-16	MV-22B	167909	VMM-266	VMM-162	15-Jun-16
12	H347-16	MV-22B	168225	VMM-266	VMM-162	15-Jun-16
13	H348-16	MV-22B	167913	VMM-162	VMMT-204	15-Jul-16
14	H349-16	MV-22B	168347	VMM-162	VMM-261	15-Jul-16
15	H350-16	MV-22B	168233	VMM-261	VMM-365	30-Jun-16
16	H351-16	MV-22B	166742	VMM-365	VMM-261	30-Jun-16
17	H352-16	MV-22B	165940	VMMT-204	VMM-774	30-Jun-16
18	H421-16	MV-22B	168601	VMM-162	VMM-261	31-Jul-16
19	H422-16	MV-22B	167902	VMM-162	VMM-261	31-Jul-16
20	H423-16	MV-22B	166723	VMM-261	VMM-162	31-Jul-16
21	H427-16	MV-22B	168346	VMM-266	VMM-263	15-Aug-16
22	H428-16	MV-22B	166687	VMM-266	VMM-263	15-Aug-16
23	H429-16	MV-22B	166721	VMM-266	VMM-263	15-Aug-16
24	H430-16	MV-22B	166741	VMM-266	VMM-162	15-Aug-16
25	H431-16	MV-22B	168222	VMM-266	VMM-263	15-Aug-16
26	H432-16	MV-22B	168230	VMM-263	VMM-266	15-Aug-16
27	H433-16	MV-22B	168235	VMM-263	VMM-266	15-Aug-16
28	H434-16	MV-22B	168243	VMM-263	VMM-266	15-Aug-16
29	H435-16	MV-22B	168291	VMM-263	VMM-266	15-Aug-16
30	H436-16	MV-22B	168293	VMM-263	VMM-266	15-Aug-16
31	H437-16	MV-22B	168295	VMM-263	VMM-266	15-Aug-16
32	H438-16	MV-22B	168233	VMM-261	VMM-365	15-Aug-16
33	H422-16	MV-22B	167902	VMM-162	VMM-261	31-Aug-16

34	H402-16	MV-22B	168638	CNAF	VMM-365	31-Oct-16
35	H445-16	MV-22B	165956	VMM-261	VMM-263	31-Aug-16
36	H446-16	MV-22B	167910	VMM-261	VMM-263	31-Aug-16
37	H447-16	MV-22B	167915	VMM-261	VMM-162	31-Aug-16
38	H448-16	MV-22B	166489	VMMT-204	VMM-162	31-Aug-16
39	H449-16	MV-22B	168337	VMM-263	VMM-162	31-Aug-16
40	H450-16	MV-22B	168602	VMM-162	VMM-261	31-Aug-16
41	H104-17	MV-22	167918	VMM-774	VMM-263	31-Oct-16
42	H105-17	MV-22	166388	VMMT-204	VMM-774	30-Nov-16
43	H134-17	MV-22B	166731	VMM-365	VMM-263	30-Nov-16
44	H135-17	MV-22B	168615	VMM-365	VMM-261	30-Nov-16
45	H136-17	MV-22B	166498	VMM-365	VMM-263	31-Dec-16
CY17						
1	H163-17	MV-22B	166383	VMMT-204	VMM-774	31-Mar-17
2	H164-17	MV-22B	166492	VMM-261	VMM-774	31-Jan-17
3	H481-16	MV-22	166719	VMM-162	VMMT-204	31-Jan-17
4	H482-16	MV-22	166744	VMM-263	VMMT-204	31-Jan-17
5	H483-16	MV-22	167921	VMM-161	VMMT-204	31-Jan-17
6	H484-16	MV-22	166720	VMM-164	VMMT-204	31-Jan-17
7	H485-16	MV-22	168029	VMM-166	VMMT-204	31-Jan-17
8	H486-16	MV-22	166390	VMMT-204	VMM-161	31-Jan-17
9	H487-16	MV-22	166481	VMMT-204	VMM-166	31-Jan-17
10	H488-16	MV-22	166483	VMMT-204	VMM-162	31-Jan-17
11	H489-16	MV-22	166486	VMMT-204	VMM-164	31-Jan-17

12	H490-16	MV-22	166490	VMMT-204	VMM-263	31-Jan-17
13	H491-16	MV-22	166496	VMM-261	VMM-774	31-Jan-17
14	H492-16	MV-22	166499	VMM-261	VMM-774	31-Jan-17
15	H175-17	MV-22B	165947	VMM-365	VMM-162	31-Jan-17
16	H176-17	MV-22B	165853	VMM-162	VMM-365	31-Jan-17
17	H210-17	MV-22B	168303	VMM-266	VMM-764	15-Feb-17
18	H211-17	MV-22B	168230	VMM-266	VMM-764	15-Feb-17
19	H212-17	MV-22B	168235	VMM-266	VMM-764	15-Feb-17
20	H213-17	MV-22B	168293	VMM-266	VMM-764	15-Feb-17
21	H214-17	MV-22B	168626	VMM-266	VMM-764	15-Feb-17
22	H215-17	MV-22B	168622	VMM-266	VMM-764	15-Feb-17
23	H216-17	MV-22B	168385	VMMT-204	VMM-263	31-Mar-17
24	H217-17	MV-22B	166391	VMMT-204	VMM-263	31-Mar-17
25	H218-17	MV-22B	166484	VMMT-204	VMM-266	31-Mar-17
26	H219-17	MV-22B	166485	VMMT-204	VMM-264	31-Mar-17
27	H220-17	MV-22B	166488	VMMT-204	VMM-263	31-Mar-17
28	H175-17	MV-22B	165947	VMM-365	VMM-264	31-Jan-17
29	H238-17	MV-22B	166386	VMMT-204	VMM-266	31-Mar-17
30	H239-17	MV-22B	166483	VMMT-204	VMM-266	31-Mar-17
31	H240-17	MV-22B	166744	VMMT-204	VMM-266	31-Mar-17
32	H241-17	MV-22B	166911	VMMT-204	VMM-266	31-Mar-17
33	H242-17	MV-22B	166742	VMM-261	VMM-264	31-Mar-17
34	H243-17	MV-22B	167902	VMM-261	VMM-266	31-Mar-17

35	H244-17	MV-22B	168333	VMM-263	VMM-162	31-Mar-17
36	H245-17	MV-22B	166724	VMM-264	VMM-261	31-Mar-17
37	H246-17	MV-22B	166733	VMM-264	VMM-261	31-Mar-17
38	H266-17	MV-22B	168645	CNAF	VMMT-204	30-Apr-17
39	H267-17	MV-22B	168646	CNAF	VMMT-204	30-Apr-17
40	H268-17	MV-22B	168647	CNAF	VMMT-204	30-Apr-17
41	H269-17	MV-22B	166691	VMMT-204	VMM-264	30-Apr-17
42	H270-17	MV-22B	167913	VMMT-204	VMM-264	30-Apr-17
43	H271-17	MV-22B	168019	VMMT-204	VMM-263	30-Apr-17
44	H272-17	MV-22B	168225	VMM-162	VMM-266	30-Apr-17
45	H273-17	MV-22B	168231	VMM-162	VMM-266	30-Apr-17
46	H274-17	MV-22B	167908	VMM-261	VMM-266	30-Apr-17
47	H275-17	MV-22B	167910	VMM-261	VMM-266	30-Apr-17
48	H276-17	MV-22B	168291	VMM-263	VMM-162	30-Apr-17
49	H277-17	MV-22B	168227	VMM-264	VMMT-204	30-Apr-17
50	H278-17	MV-22B	168329	VMM-264	VMMT-204	30-Apr-17

Source: Created by author using data from ATOs and AHMS provided by provided by Richard D. Shirley, V-22 Configuration Manager, Commander Naval Air Force Atlantic/Commander Naval Air Force Pacific, N421, Norfolk, VA, e-mail correspondence with author, 14 March 2017.

BIBLIOGRAPHY

Government Documents

Chief of Naval Operations. OPNAVINST 3710.7U, *Naval Air Training and Operating Procedures Standardization General Flight and Operating Instructions*. Washington, DC: Department of the Navy, 22 November 2016.

Commandant of the Marine Corps. NAVMC 3500.11D, *MV-22B Training and Readiness Manual*. Washington, DC: Department of the Navy, Headquarters U.S. Marine Corps, 24 October 2014.

Commander, Naval Air Forces. COMNAVAIRFORINST 4790.2C, *Naval Aviation Maintenance Program*. San Diego, CA: Department of the Navy, 15 January 2017.

Commanding General, 2d Marine Aircraft Wing, II Marine Expeditionary Force. Wing Order 3501.4F, *Aircraft Readiness*. Cherry Point, NC: U.S. Marine Corps, 14 September 2016.

Commanding General, 2d Marine Aircraft Wing, II Marine Expeditionary Force. Wing Order 3710.38C, *Standing Operating Procedures for Flight Operations in 2d Marine Aircraft Wing*. Cherry Point, NC: U.S. Marine Corps, 19 March 2014.

Joint Chiefs of Staff. Joint Publication 3-30, *Command and Control of Joint Air Operations.* Washington, DC: Government Printing Office, 2014.

Marine Aircraft Group 26. "The Mission of VMM." U.S. Marine Corps. Accessed 14 November 2016. http://www.mag26.marines.mil/MAG-26-Units/VMM-263.

Marine Corps Center for Lessons Learned, Training and Education Command. *MV-22 Tiltrotor Operations in Iraq-Lessons and Observations from VMM-263 Deployed October 2007 - April 2008 OIF 06-08.2*. Quantico, VA: Training and Education Command, 14 May 2008. Accessed 14 November 2016. https://www.mccll.usmc.mil/index.cfm?disp=myIdolSearch_xml.cfm&refine=Campaign|OIF.

Other Sources

Benjamin, Kristy. Aviation Curator, National Museum of the Marine Corps, Quantico, VA. E-mail correspondence with author, 29 July 2016.

Clinton, Robert. V-22 Current Readiness Mentor/Advisor, MAG-26, Marine Corps Air Station New River, Jacksonville, NC. E-mail correspondence and telephone conversation with author, December 2016-April 2017.

Harris, Scott. Executive Officer, VMM-261, Marine Corps Air Station, New River, NC. Telephone conversation with author, February 2017.

Rock, Paul J. Director, Policy and Strategy, J5, U.S. Southern Command, Miami, FL. Telephone conversation with author, August 2016.

Sax, John. Field Grade Rotary Wing Monitor, Quantico, VA. Telephone conversation with author, April 2017.

Shirley, Richard D. V-22 Configuration Manager, Commander Naval Forces Atlantic/Commander Naval Air Forces Pacific, Norfolk, VA. E-mail correspondence with author, 14 March 2017.

Weidl, Mike. Programs, Plans and Policies, Headquarters, U.S. Marine Corps Aviation, Pentagon, Arlington, VA. E-mail correspondence with author, August 2016-April 2017.